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Immigration and the Contractor

LITTLE attention seems to have been given in engineering and contracting circles to the possible influence on the cost of construction of the immigration bill, which has recently been passed by Congress and is expected shortly to be before the President. If the measure is signed, writing the literacy test into our law, it will doubtless have a marked influence upon immigration from Eastern Europe—from Russia, Austria Hungary and the Balkans. Large numbers of foreigners from these parts are engaged on contracting work and in factory operations where skill is not required. Scarcity of such labor will, therefore, mean higher costs in construction and in many manufacturing operations. This by itself is not a sufficient reason for vetoing the bill, but certainly it is a result which contractors and manufacturers should foresee.

Sweeping Bond Decision

THE decision recently handed down by the State Supreme Court of Washington in the case of the Puget Sound State Bank vs. Gallucci, will seriously interfere with the letting of all State, county and municipal contract work in that State. In effect it holds that a bonding company is liable for the full amount of claims against the contractor, even if these claims exceed the amount of the bond. Under such legalization of the principle of unlimited liability of bonding companies, no contractor's bonds can be written except at prohibitive expense. Indeed at present it seems that no contractor's bonds will be written in that State on any terms till the laws on which this decision is based are revised. This decision reduces the writing of contractor's bonds from a business to a game of chance, and practically prevents the municipalities and the State from securing surety for the performance of contracts at a reasonable cost. It is to be hoped that the State will be speedily convinced of the unsound principle behind this decision, and will take immediate steps to counteract the injurious effects already manifest as a result of it.

Winter Concreting

REGULARLY each winter the Engineering Record has had to call attention to the danger of placing concrete in cold weather. It has yet to find, however, with the exception here to be related, a case in which an owner has been taught a severe lesson and has not thereafter handled his materials more intelligently. The case in question was recently observed by one of the representatives of this journal. A certain concrete building had suffered severe damage (though not by frost) and was being repaired. The work was being prosecuted in freezing weather and without any protection at window openings. Salamanders were placed on the floor but the wind, having free sweep, nullified their effect. As a consequence ice was found on a floor immediately alongside the finished portion, while a knife blade could be run to full depth into a repaired column from which the steel form had been removed after being in place four days. One cannot repress criticism at such a condition, and yet the work is being carried on under the direction of those fully informed as to the action of frost on concrete.

Tardy Use of An Enviable Record

FOLLOWING the recent accident which tied up the New York subway for a day, but which resulted in only one fatality, the Interborough Rapid Transit Company, which operates the tube, began publishing in the New York papers the safety record it had made. This publicity campaign was in answer to newspaper criticism of the yellow variety, entirely uncalled for and prompted by the response which could be counted on from the unthinking. The record is called the most marvelous in the world, in the advertisements now running. It shows that during a period of five years the fatal accidents upon steam railroads in the United States numbered one in 2,600,000 passengers, on the London underground lines one in 25,000,000 and on the elevated and subway lines operated by the Interborough Rapid Transit Company one in 842,620,000. The company, therefore, declares that it operates the safest passenger railroads in the world. While it is true that the number of miles per trip is very much shorter on the elevated and subway lines than on steam railroads, the record is none the less an enviable one. The only regret is that the company has not seen fit before this to take measures for cultivating the good will of the New York public by giving out such data as that which it is now effectively using.

Publicity Versus Secrecy

A DECADE ago it was taken for granted that when a railroad wreck, large or small, occurred the railroad should diligently keep details of the disaster from the press and the public. Doubtless many of the minor accidents were kept out of the papers, but the bad ones were featured in large type, the reporters drawing upon their imaginations to make up for the deficiency of facts. The railroads, in consequence, were justly upbraided for their attempt to conceal the truth. How well progressive railroad managements have come to see the folly of this course is exemplified in the procedure of a superintendent of the Baltimore & Ohio on the occasion of a wreck on his division. When the first news reached him he telegraphed to the daily papers likely to be interested, requesting that representatives accompany him to the scene or that local correspondents be advised. Thus the incentives to use their imaginations and to rely on incompetent witnesses were removed, and only the facts were printed. Unfortunately there are still managers in every line—even in charge of public engineering works—who fail to appreciate that the safest course when there has been a disaster is to give out all the facts.

Rash Talk in High Places

ELSEWHERE in these pages will be found comment on the broad influence for the public good exercised by corporation schools such as that conducted by the American Bridge Company at Ambridge, Pa. This is a work in which it seems necessary that industry must engage, despite the fact that the greatest good is to the community and not to the organization. Yet at the time corporations are thinking more and more seriously of engaging in such work, a man prominent at present as a public official preaches doctrine which is sure to enforce the arguments of the apostles of discontent and to negative the excellent work being done by corporation schools and other agencies. The chairman of the United States Commission on Industrial Relations, Frank P. Walsh, last Sunday fulminated against large aggregations of capital, and even advocated their confiscation. No one denies that there were flagrant abuses by capital previous to the present agitation for regulation and that there are abuses still. But to hold that the remedy is to confiscate property is to destroy the whole basis on which our economic structure rests. With this revelation of Mr. Walsh's method of thinking we cannot look to the Industrial Relations Commission for a safe and helpful solution of our industrial ills, unless it be through a most vigorous opposition report by other members of the commission.

Engineering Problems of the War

EVERY war affords great scope for the skill of the engineer and the present terrific struggle has already presented some questions of startling significance. Reference has already been made in these columns to the gigantic tasks of transportation which are being performed. Not less in importance, however, are some other problems which demand immediate attention for efficiency and solution.

One of these is to find the material of maximum effective resistance to high explosives. It seems to have been demonstrated effectively that concrete, which has been the main reliance in modern fortifications, is almost useless in its customary form. The turrets of permanent concrete forts were rendered useless by a few rounds of shells charged with high explosives. From the photographs of the demolished works it appears that even when the turrets themselves were not demonished they were fairly blown off their foundation by the complete shattering of the concrete bases. On the other hand, temporary earthworks and one or two forts heavily reinforced with earth appear to have resisted attack by high explosives measurably well. A shell penetrating a few feet into concrete rends the whole mass, while in earth it merely opens a crater which is partly filled again by the falling dirt. It was noticed in our Civil War that an active shoveling party could in a short time repair the damage of a heavy bombardment where an earthwork was concerned.

The questions now to the front are whether any reinforcement of the concrete will be of service, or whether a proper choice of earth construction will so muffle the explosives as to make them comparatively ineffective. A few feet of loose dirt or even of snow will stop a bullet which would punch a half-inch iron plate, and the same principle seems to hold for heavy projectiles.

Another problem is directly in the line of efficiency studies and requires prompt solution. What form and size of digging tool will enable a man crouching or lying prone to dig himself into protection in the minimum time? This is a totally different matter from ordinary digging, where a man is standing and is able to use an ordinary spade; it requires a study of economical effort under very special conditions. Again, can two or three men co-operating and working with suitably chosen tools get under cover more quickly than if working independently? If so, how should they work? Armies are certainly going to be provided with the best tools for the purpose if anyone can find out what they are. A large variety of small intrenching tools have been tried without getting down to any standard form or forcing even an approximately scientific study of the subject.

Another field for efficiency studies is opened by the motor vehicle, now become a most important part of military equipment. What construction gives the quickest replacement time for the commonest breaks, and what form, if any, of transportable bridging will get a vehicle over a mud hole in the road or the crater of an exploded shell? Motors at the front are undoubtedly taking routes that one would call utterly impracticable at first glance; what then are the best auxiliaries to keep them out of trouble?

All these, be it noted, are purely problems of engineering not unlike those which one meets in the most peaceful work of construction. It is only because of sudden war conditions that they become urgent and assume a military aspect which is unfamiliar.

Training For Municipal Service

AMONG the several papers on subjects of general public interest presented at the recent annual meeting of the American Society of Mechanical Engineers was one entitled "Training for the Municipal Service in Germany," prepared by Clyde Lyndon King, of the Wharton School of Finance and Commerce, University of Pennsylvania. German efficiency is now doing away with waste in public business due to inadequately trained and improperly equipped officials and employees. There are four chief factors responsible for the rise of municipal universities in Germany: First, the rapid increase in urban population, with many times greater increase in governmental functions; second, a demand for local institutions which would offer the training necessary for officials; third, the need for training the rank and file of city employees, and fourth, the recognition of public service as a vocation of dignity, with permanence of tenure and opportunities for progress. A German city selects its leading officials and technical advisors without geographical restriction. Salaries are adequate to attract the best talent and increases follow at specific intervals. Two differences of fundamental importance between German and American civil service methods were pointed out by Mr. King: German examinations are qualifying only, not competitive, while an appointing officer is not limited to the first one or the first three on an eligible list, but may select from those who have qualified the person best fitted for the place to be filled.

American communities are already advancing toward better public service. An example of this mentioned in the Engineering Record of Dec. 26, is New York's special classes for engineering and other employees. Not many years ago, it was thought needful for American engineers to travel to Europe to get the best information and see fine examples of works in several lines of engineering, but of recent years America has taken her place with the leaders in these lines, and it is a daily experience to have engineers and officials from abroad visiting works here. Likewise, having begun to discover her deficiencies in municipal efficiency, she may be expected to achieve an American solution of the problem that will be best for American conditions. Local needs for training in minor services should be met by suitable local schools. For the positions, fewer in number, requiring advanced training, the courses of preparation should be partitioned among the universities and technical institutions in such a way as to avoid undesirable duplication. For both the minor and higher employments preparatory instruction should be given, at least in part, by men in active practice, or men who have had actual experience in the particular kind of position—mechanical, clerical, technical, legal, administrative.

Courses of training for several branches of municipal service are given by a number of universities in the United States. In civil engineering, the professional courses of necessity deal largely with public works, such as water supply, sewerage and pavements. An engineering training inevitably lays much emphasis on efficiency, and as a logical consequence the engineer is doing an increasing proportion of work in the public service. His influence and his methods of training are becoming an important factor in securing higher efficiency and a better conception of the duty of public officials and employees.

The Microscope—A Tool for the Concrete Engineer

IN this issue the Engineering Record begins the first of a series of six articles on the use of the microscope in studying the character of concrete. It is impossible in the first article to do more than introduce the subject, but as the series develops we believe that the influence of the method on the future of concrete construction will become apparent.

The fundamental importance of Mr. Johnson's method lies in the fact that by it we are able to study concrete as it is, not as it seems to be. It is axiomatic that the strength of any material is dependent on the arrangement of its smallest particles, yet we have been content with ocular examination of concrete, which does not reveal the true nature of the smallest particles. When compressive strengths were low we looked for deficiency of cement, weak aggregate or careless mixing, never sensing that even with ample cement, strong aggregate and thorough mixing there was a most startling deficiency in strength as compared with the native stone used in the mixture. Why, for example, should we, in a 2000-lb. concrete, be obliged to use a stone testing 10,000 lb. or more to the square inch? Why could we not use a weaker stone, if it would be cheaper, and still get a concrete strength of 2000 lb. The microscope, as is evident from the article on page 98, gives the answer.

This, moreover, is but one of the hitherto unsolved problems that yield to the microscopic method. New light is shed on the actual progress of disintegration in concrete, on the reasons why present volumetric methods of proportioning give incorrect results, on the influence of the thickness of the cement films upon the strength of the mixture, and, most astonishing of all, on the tremendous waste due to the failure of present mixing methods to secure the complete hydration of the cement. In connection with the last point, there is opened up a vista of wonderful possibilities in increasing strengths far beyond anything now attainable.

Without having the complete series of articles before them readers may be inclined to consider the researches to be of purely academic interest. The development of the series will show that such is not the case. One evidence of their practical value is that the studies are being financed by a commercial organization.

It should be understood that these articles are offered in a constructive spirit. Necessarily, however, before remedies can be found the faults must be clearly studied and diagnosed. Only when they are thoroughly understood is it possible to begin to think of remedies. The constructive work of the series does not become evident until the final article, but its influence will more than overbalance the possible destructive effects caused by the previous exposition of defects.

Mr. Johnson does not contend that he has exhausted the possibilities of the microscope in the study of concrete, nor that later studies may not controvert conclusions which now appear undeniable. He presents the method as a tool for the concrete engineer, urging that it be widely adopted so that the accumulation of microscopical evidence and more exhaustive study may push farther the bounds of knowledge regarding the true character of concrete. Eventually such study can have no other result than a beneficial result on structural work.

Uniform Filtration Statistics

NOW that filtration and other forms of water purification have become so common in this country and figure so largely in the annual reports of water departments, it is becoming necessary in the interests of clearness, accuracy and economy of printing to standardize the form of the tables used in published reports. Students of the art of water purification, who read the descriptions of filters and records of filter operation as they are ordinarily published, almost always find some essential item lacking or else uncertainty as to what is included in some of the items. This often prevents the rest of the facts from being used for purposes of comparison.

To remedy this condition the New England Water Works Association appointed a committee to consider the matter and suggest schedules to serve as the basis of water-purification statistics. The report of this committee, which was presented at the recent annual meeting of the association, contains twelve tables, which cover such matters as the chemical and bacteriological character of the unfiltered water, a statistical analysis of the bacteria in the filtered water, various items that relate to the service of the filter. the quantity of water filtered, rates of filtration, amounts of chemical used and classified costs. These schedules are regarded by the committee as tentative, and the whole report is to be open for discussion at the next meeting of the association, in February.

Some of the recommendations of the committee are at variance with present practice and mark a step in advance. For example the practice of computing the percentage removal of bacteria is entirely abandoned. Engineers know that this has no practical value and may be used so as to give laymen a false sense of security. In its place the committee suggests a more thorough statistical study of the analyses of the filtered water, based on the frequency with which results of a certain character are obtained. The table in question calls for the median as well as the mean and for the numbers of samples which gave results between stated limits. Recognizing that no filtration process can be perfect, the attempt is made to show what the normal results are and for what period of time and to what extent the results depart from this normal.

Again, the committee recommends that the amounts of chemicals be expressed in pounds per million gallons instead of in grains per gallon. The former method has gradually been supplanting the latter, on account of its greater convenience. Chemicals are purchased and weighed out by the pound, while the water treated is measured in million gallons. "Grains per gallon" is a laboratory unit, useful perhaps to the chemist, but even he finds "parts per million" a more convenient unit.

The report calls attention to the fact that in many places the cost of pumping to the filter is not included in the cost of operation and recommends that this be included in the schedule as a separate item.

Absolute uniformity in filter statistics is of course neither possible nor desirable. Doubtless the schedules suggested will not meet the needs of every case. But if filter operators will use these tables, modified, as they doubtless will be, as a result of the coming discussion, a greater interchange of profitable data will become possible, and a long step forward will have been taken in the art.

Bridge Company's Contribution to Solution of the Unrest Problem

RECOGNIZING its opportunity to safeguard its employees from the influence of those who spread the doctrine of discontent and realizing also the economic advantages from the employment of well-trained workers, not a few industries are undertaking educational work. The movement apparently started with purely commercial considerations in mind and attracted widespread public attention first in the success of schools for salesmen in such companies as the National Cash Register Company and the Burroughs Adding Machine Company. One has only to avert, however, to the apprenticeship systems of the large electrical companies and the railroads to realize that the opportunities for corporation schools in technical lines have not been neglected. In fact,they antedated salesmanship schools, and are themselves but the successors of the apprenticeship system. Nevertheless the possibilities, taking manufacturers as a whole, are only vaguely sensed by those whose businesses are constantly hampered by labor troubles and whose only hope for success in stemming the tide of discontent, now so serious a danger, lies in education. An indication of what can be done is furnished by the classes conducted at Ambridge, Pa., by the American Bridge Company, described at the recent Philadelphia meeting of the American Association for the Advancement of Science by J. E. Banks, principal of the school and engineer of the company's Bureau of Standards.

Two different lines of instruction are given, elementary English and engineering, the subjects under the latter heading ranging from arithmetic to calculus and from strength of materials to bridge and building design. Theory, not shop practice, is taught, for the students get the latter in their daily work. Though the classes are held at night and there is a nominal fee, not by any means sufficient to meet the expenses of the course, there were no less than seventy-eight students in the eight classes. The students are (a) boys sixteen years of age and older who have left school before reaching the eighth grade; (b) men twenty to thirty years of age who find themselves in need of further education, and (c) foremen and other older men who find that they are hampered in their work by lack of knowledge of arithmetic, mechanical drawing and elementary mechanics.

The English classes are designed for the foreign-born and foreign-speaking employees, largely Poles, Bohemians and Russians.

Of more importance than the details of the class work is the spirit in which the company has engaged in this activity. Its ideal is to give every employee the educational opportunity needed and further his way toward success. Furthermore, it recognizes that his progress will be influenced largely by his home surroundings, and it, therefore, has extended its activities in English instruction to the families, the wives and children, of the employees.

The benefit of such training to the recipient is self-evident. The company profits not only through the increased capability of its employees, but through the resulting esprit de corps, which is a direct result of the employees' appreciation of the company's interest in their welfare. There is a marked improvement in the mental attitude of those who take the courses. They are happier and more alert. Work to them has ceased to be a hum-drum drive. Their studies have given them a new horizon. Their tasks are now part of an important whole; they have ceased to be mere soulless cogs.

One cannot read Mr. Bank's paper without realizing that, after all, the immediate gain to the company in the added efficiency of its employees is of secondary importance. The main benefit is in the sociological side, the reclaiming of those already in the ranks of discontent, and the expansion of the horizon of others who, left alone, would surely drift in that direction. Such work properly is the duty of the State, but never has the machinery been developed to discharge it properly. What the State fails to do, private parties, by one agency or another, must attempt, and the plan pursued at Ambridge and at other places allows this civic responsibility to be assumed, the while the organization itself is directly benefited. True it is that only a relatively small number avail themselves of the opportunity, but it must be remembered that the leaven is smaller than the meal, and that the mere offering of the opportunity robs the agitator of his argument. There is need for a very much wider extension of the movement—to every industry in fact, for there is not a single organization in which employees are not held back through lack of opportunity and of a horizon necessary to raise their tasks above the deadening level of routine.

Microscope Opens New Field in Study of Concrete

First of a Series of Six Articles Treating of the Causes of Such Defects as Exist in Concrete and Indicating Remedies Therefor

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> *STRIKING developments in any art come only at infrequent intervals. Their significance is often impossible to estimate in the beginning, for, being departures, there is no measure by which to compare them. Such is not the case with the development described in the series of articles, of which this is the first. In metallurgy the use of the microscope opened up new possibilities, only now being fully realized. That the application of similar methods to the study of concrete promises to lead to equally important conclusions seems evident from a study of these articles. Convincing as are the points made here, no less important are the conclusions in later articles of the series, leading finally to the demonstration of an astonishing low "efficiency of use" of the cement, due to inadequate methods of securing hydration. The series should lead to a new era in the study and improvement of concrete.*
>
> —EDITOR.

THE possibilities of the microscope as a tool for the concrete engineer—such is the keynote of the present series. In view of service the microscope has rendered the metallurgist, it occurred to the writer that it would be equally valuable in disclosing the real character of concrete. Concrete, no less than steel, is dependent for mass perfection upon the perfection of its smallest parts, and in no way so far known can the quality of these small components be so well, so quickly and so accurately determined as by the use of the microscope.

The work to be described was first undertaken about three years ago at Sibley College, Cornell University; and during the past year has been prosecuted under an Industrial Fellowship established by the Raymond Concrete Pile Company. The writer takes this occasion to acknowledge his indebtedness to the officers and staff of Sibley College and other colleges of the university, both for permitting extensive use of apparatus and equipment and for personal encouragement and advice. The author also extends his thanks to the many individuals throughout the country who have responded, at much trouble to themselves, to requests for samples of concrete from various structures, without which this research would have been greatly restricted.

GENERAL CONSIDERATIONS

There is special reason, moreover, why every means for studying concrete should be investigated, for no other construction material to-day, not excepting steel, has so widespread a use and enjoys so great a popularity. Its possibilities are limitless. Its applications are numberless. Its making and forming are of the simplest. Some roughly measured stone and sand from a convenient bank, a little cement from a nearby dealer, some water, a little turning with shovels or by machine, a board form, and the trick is done. This is essentially true whether the work be great or small. From an economic standpoint, whether the economist be witting or unwitting, professional or lay, skilled or unskilled, educated or ignorant, such an appeal is irresistible.

But desirable as it is to have so easily made, so adaptable and so cheap a material within the reach of everyone, those very qualities have led to its abuse; and with abuse inevitably has come failure. It is a peculiarity of Portland cement concrete that a fair degree of success is not prevented by a great deal of bad treatment in making, and that concrete made by bad treatment looks almost as well, at the start, as that which is properly made. It takes time—oftentimes years—to reveal the hidden weakness, but time will surely bring it to light. There have been some unfortunate failures in the past, but there are more to come in the future, and these will give Portland cement and Portland-cement concrete an undeserved reputation for unreliability, unless it can be shown why these failures occur, how they may be prevented, and in what ways our present methods or materials must be changed to make concrete "as enduring as the living rock."

USE OF MICROSCOPE

It will doubtless appear at first blush that the lack of homogeneity of concrete and the uncertainty of proportioning attendant upon usual methods of mixing and placing would make microscopical examination of little value, so far as actual construction operations are concerned, especially as the examination is made of samples of restricted size. The same objection might be raised with equal justice in regard to the examination of steel. It is impossible to examine the whole of one ingot, or the whole of every ingot from each heat, but by taking representative samples from each ingot, or from each bloom, and thus knowing the quality of the product, with this information and a knowledge of the raw materials —the ore, or pig iron, the flux, fuel, etc.— that entered into it, very close control is possible on huge-scale operations.

It is the belief of the writer that the same will prove true of the microscopic examination of concretes. The method is so

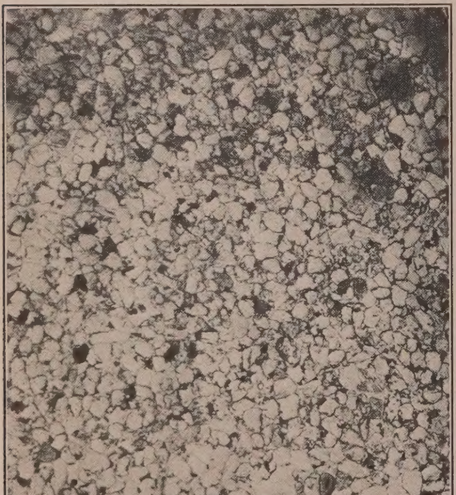
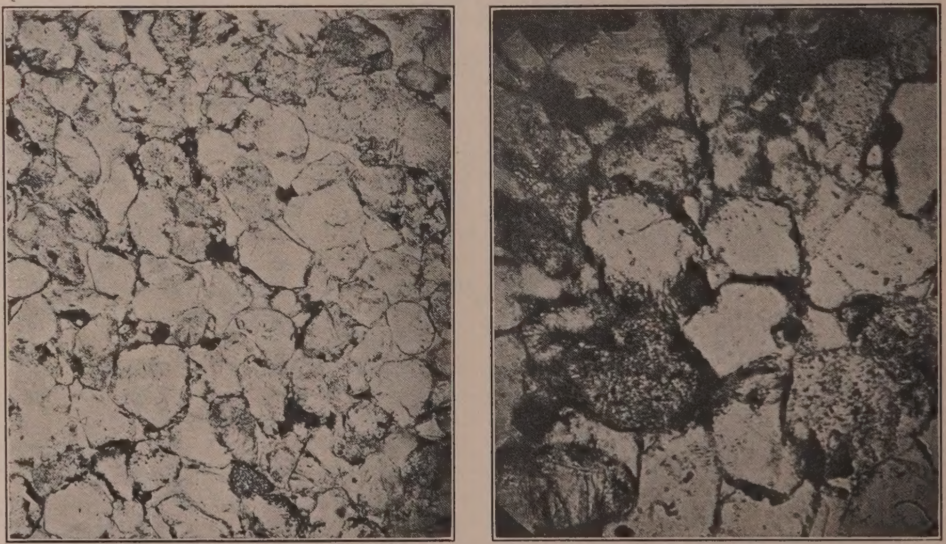


FIG. 1—SANDSTONE GRAIN MAGNIFIED 40 DIAMETERS



80 Diameters

200 Diameters

FIG. 2—ENLARGEMENT OF SANDSTONE GRAIN SHOWN IN FIG. 1

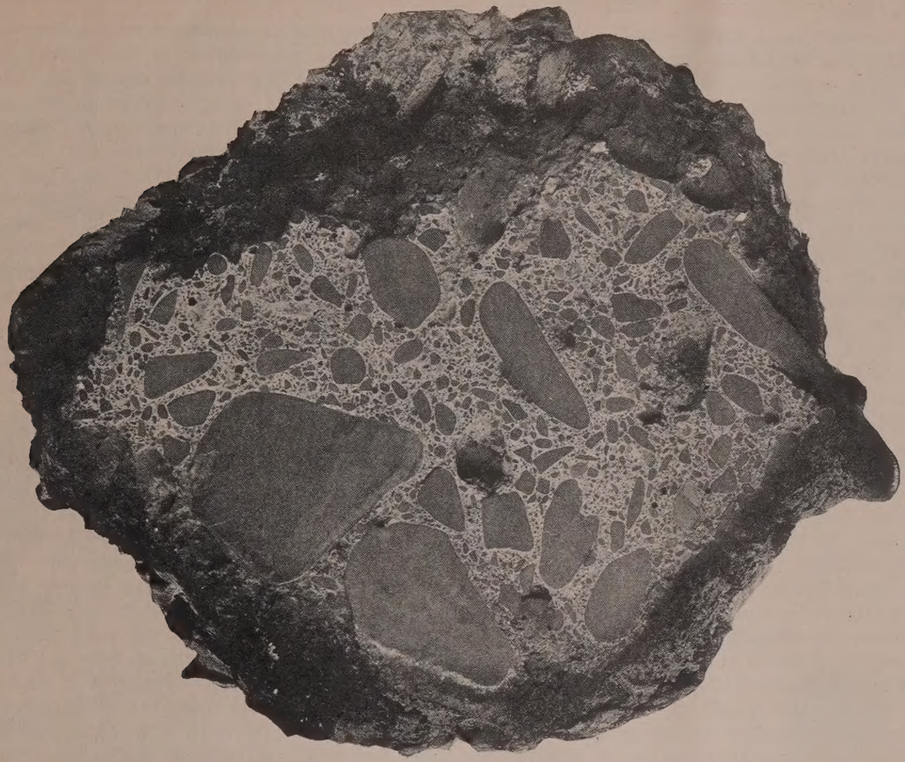


FIG. 3—CONCRETE FROM WING WALL OF DAM AT CORNELL UNIVERSITY

About half natural size

simple, so direct, the results so indisputable and convincing, that it should make a very powerful appeal to everyone interested in the concrete industry. Nor is the apparatus required necessarily elaborate or expensive. It should further be remembered that in this work light is reflected from a single polished surface, which greatly simplifies the procedure. It is neither advisable nor necessary to grind down the section until light can be transmitted through it, as has been required in most of the microscopic work done heretofore on cements and rocks.

It is impossible, in a few lines, to do more than to indicate some of the possibilities of microscopic examination in concrete work—the quantitative analysis of concretes; the detection of impurities, such as vegetable, adhesive clay or other films on the sand or stone; impurities and adulterants in the cement. Although this article and those following are not primarily intended as an exposition of microscopic investigation, a few illustrations of such uses will be given and a few points touched upon which, it is hoped, will make a direct appeal to all who are interested in obtaining better concrete. It is hoped, also, that this appeal may prove general, and that microscopic examination will not be confined to the few whose names are already well known, but may soon find its way into every cement laboratory worthy of the name.

PRELIMINARY CONSIDERATIONS

Before taking up the detailed study, a review of what is well known in regard to the general nature of concretes and their making may prove of value. In this review it will simplify matters to put aside for the present all chemical questions in regard to the nature or the manufacture of cement and to assume that the cement is a perfect product which forms, when mixed with water, a sort of "mineral glue" which coats the sand grains and the stones so that they stick together. In other words, take the name at face value—as "cement."

There are four substances which enter essentially into concrete—stone (crushed stone or gravel), sand (either natural sand or crushed rock), cement, and water.

These four substances are necessarily variables. Each has certain inherent properties which must be taken into account in forming the mass. If cement and water are considered as one substance, i.e., as a glue, the number of variables can be taken as three. What relation, then, do these substances bear one to another? And what function does each perform in the concrete?

The first requisite in concrete is strength, whether tensile, compressive or shearing. The second requisite is density, but experience shows that density and strength are correlative. This is true of natural stones as well as of concretes (Tests by R. L. Humphrey, Eng. & Mining Jour., June 20, 1902, page 921). Obviously, also, the strength of the composite product cannot exceed the strength and density of the strongest and densest of the materials.

STRUCTURE OF STONE

Assume for convenience that sandstone is selected as the coarse aggregate and sand of like nature as the fine aggregate. The structure of a sandstone sand grain, as seen through the microscope, is shown in Fig. 1. As a piece of the coarse aggregate exhibits throughout an exactly similar structure, it is fair to take the ground that all of the pieces of stone that go into the concrete are built up of tiny particles in the same way. Further, it is found that any part of a larger mass of the stone, such as a test cube, shows the same structure throughout as the sand grain, so that the strength per unit area inherent in the sand grain should be the same as that inherent in the test cube, which crushed at 12,200 lb. per square inch. Therefore, considering for the sake of simplicity, that all stresses in the concrete are compressive, if a concrete is made of this stone and this sand, any failure to withstand a crushing stress of 12,000 lb. per square inch must be ascribed

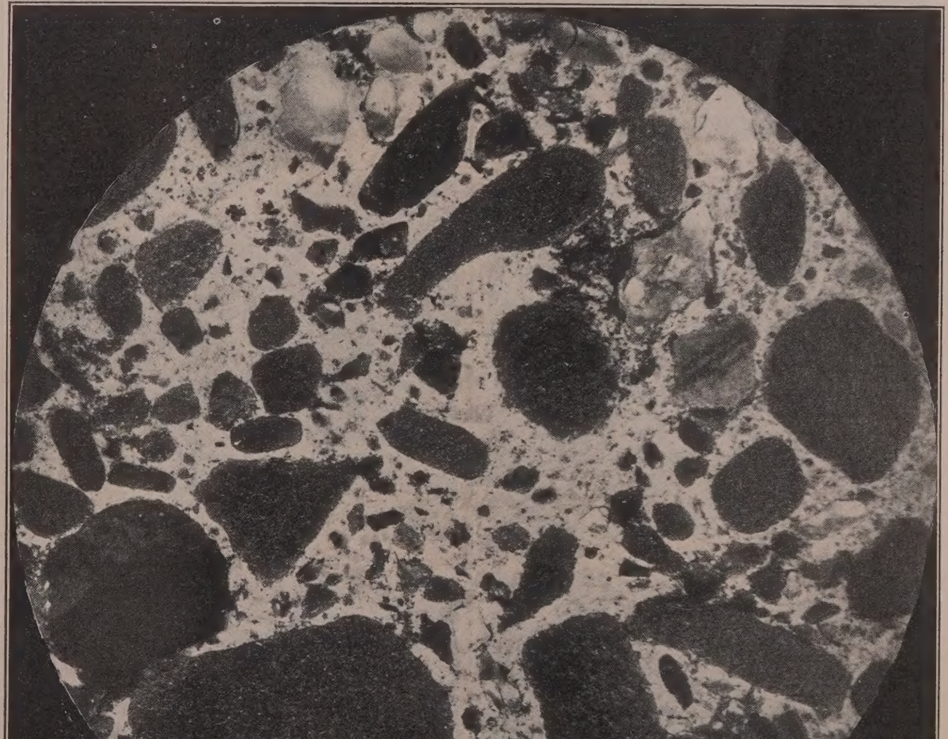


FIG. 4—PHOTO-MICROGRAPH OF MORTAR TAKEN FROM SPECIMEN SHOWN IN FIG. 3

either to the properties, the quality, or the improper use of the cementing material which holds the sand particles and the stone particles together, or else to the presence of some foreign substance in the matrix in which the particles are embedded.

CONCRETE SHOULD APPROACH STONE IN DENSITY

It is axiomatic and also corollary to what has been before stated, that the more nearly a concrete approaches natural stone in density, the better and the more economical will it be. If Fig. 1 is examined closely it will at once be seen that the sandstone sand grain is, of itself, a concrete, that it consists of tiny particles, closely compacted, held in place by, and filled between with, some cementitious substance, which is known to be either iron, or silica, or both. Magnifying this same spot to a higher degree, as in Fig. 2, the similarity between this natural and artificial concrete is made even clearer. But there is one marked difference, which is very evident, i.e., in natural stone the component particles are packed far more closely than are those of artificial concretes, and the cementitious layer between them is far thinner than the layer obtained by artificial means. This is a significant point and should be remembered.

Considering a hypothetical case, assume that 1:2:4 sandstone concrete in pure compression breaks at 2200 lb. per square inch at a mature age, say, 1 year. The cement alone should not crush below 8500 lb. per square inch, nor the sand or stone below 12,200 lb. per square inch. To the eye, the concrete appears perfect. Some tiny air holes may be visible, but these could hardly account for the comparatively low strength. The concrete may be struck with a hammer, or pulverized in a mortar, or analyzed chemically, and the relatively low strength attributed to "water-worn sand," or "dirty sand," or "poor cement," or any one of a hundred commonly-assigned possibilities. The problem is a serious one, *for so far as the strength shown by the concrete is concerned, we might better have used shale, or some waste rock that would crush at not less than* 2200 *lb. per square inch,* instead of the expensive stone. Further, this strength of 2200 lb. per square inch is in considerable excess of the average strength of concrete made under field conditions, so that, so far as concerns the strength of the product that is being turned out by hundreds of thousands of yards daily, an even poorer grade of stone might have been used, with a tremendous saving to contractor and owner in cost of aggregate.

Extensive tests, however, would seem to disprove the correctness of the foregoing reasoning. Under certain conditions, the ultimate strength of a concrete may equal the strength of the stone aggregate (Taylor & Thompson, "Concrete Plain and Reinforced," pages 391 and 392), though this is by no means true of all concretes. However, wide experience leads to the belief that a strong aggregate makes a strong concrete, and a weak aggregate, a weak concrete. Theory and practice are seemingly antagonistic, but it may be that this established fact and the conclusions of the foregoing paragraph will after all be found to agree if the nature and structure of concretes be studied carefully.

IDEAL IN PROPORTIONING

The theoretical ideal in proportioning materials for concrete is to approach maximum density, i.e., the density of the large aggregate, by putting in just enough sand to fill the spaces between the stones, and sufficient cement to coat over the entire surface of the stones and of the sand grains, as well as to fill the spaces between the sand grains. The exact volumes of these stone-voids and sand-voids are often determined for practical work with the greatest care, but when concrete is proportioned on

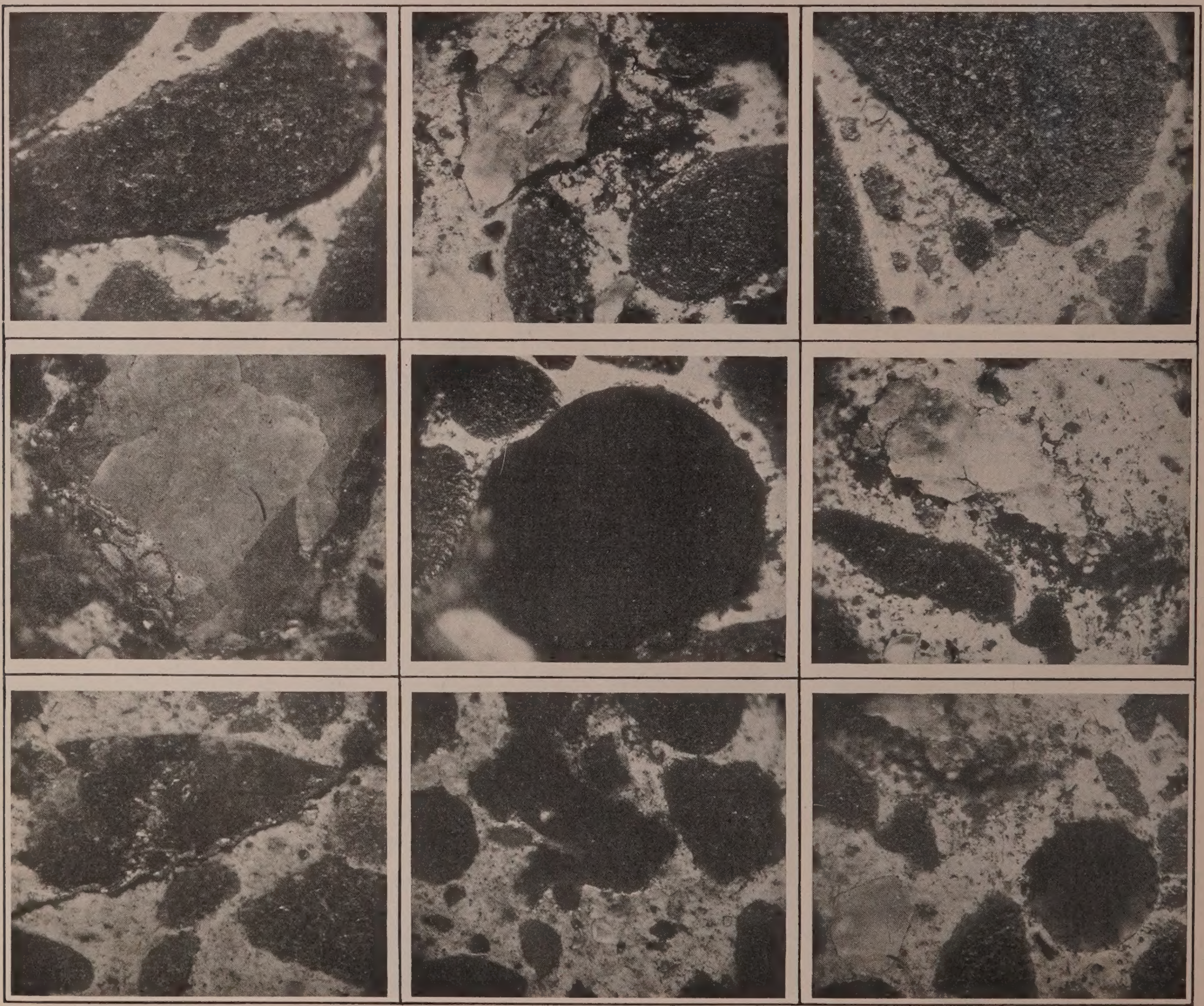


FIG. 5—MICROSCOPIC TRAVERSE OF MATRIX OF CONCRETE SPECIMEN SHOWN IN FIG. 4

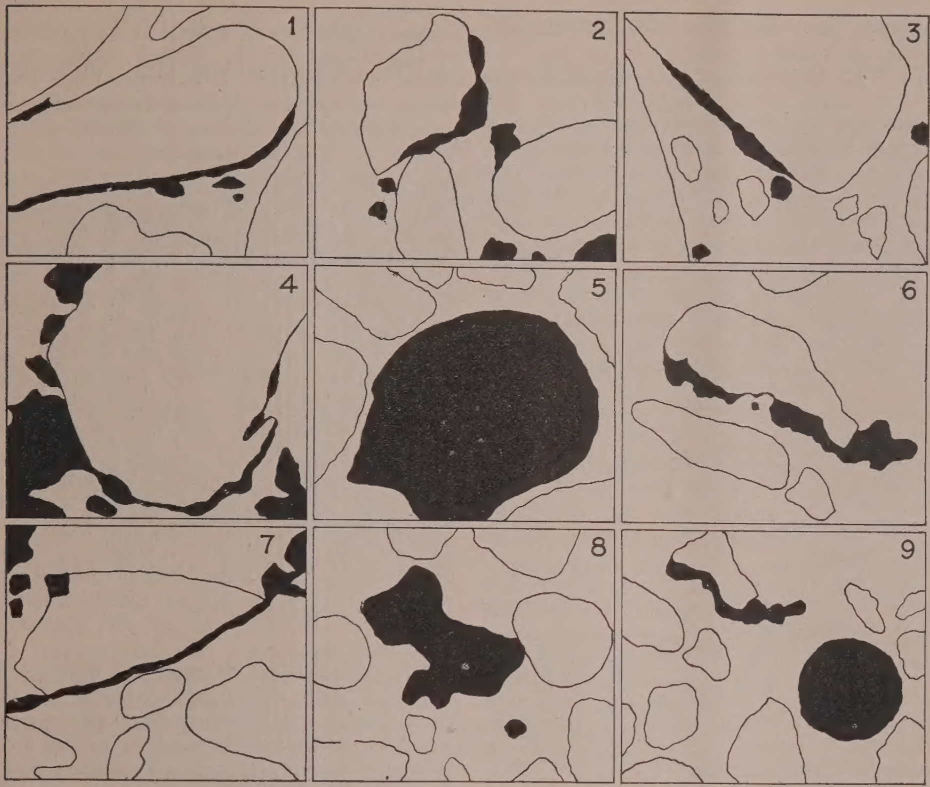


FIG. 5A—KEY TO VOIDS IN NINE ILLUSTRATIONS OF FIG. 5

the basis of such determinations, something seems to go awry. The concrete does not show maximum density, as was planned, oftentimes far from it. Distrust of proportioning on the basis of void determinations has been growing rapidly of recent years. Evidently, either the ideal is wrong, or the method of attaining it is poorly chosen.

It may help in understanding these matters to look at the inside of concrete of known composition, made by approved field methods. The specimen shown in Fig. 3 was taken from the wing wall of a dam at Ithaca, N. Y., this dam being part of the hydraulic power development of Cornell University in Fall Creek Gorge. Unusual care was taken in proportioning, mixing and placing this concrete, in order to have it water-tight, so that the specimen may be considered a representative product of accepted field practice.

The specimen was prepared by grinding until a smooth surface was obtained. As the plane of this surface would have laid about 8 in. from the outer face of the wing wall, its features should be characteristic of the entire structure. As is usual, when void determinations were made on this stone, it was shaken down, in order to compact it as closely as possible. Evidently, in the present relative positions of the stones, the percentage of voids would be enormously increased. This would also be true, though to a less degree, even if the stones had not been shaken down. If this same increase of voids holds for the sand, the unreliability of void determinations as a basis of proportioning is readily understood.

AIR HOLES

The next most striking feature of this surface is the number and size of air holes visible. Some of them are very small, so small as to seem negligible, while others are of appreciable size. One or two lie directly adjacent to pieces of stone. If the surface were magnified a hundred times it would be a field 100 ft. on a side, with each stone a boulder and each air hole a cavern. Further, these large air voids (and the small ones as well) are of indefinite size and depth below the surface, so that conditions may be better, or may be worse, in other portions. Evidently, however, the matrix of sand and cement in which the stone is embedded is of uncertain texture. As this matrix is relied upon, not only to hold the stones together against disruptive stresses, but also to transmit compressive and other stresses from one stone to another (it being remembered that the stone has the greatest density and greatest strength of all the constituents of the mass), it is evident that some or all of these stones will be called upon to bridge air gaps of greater or less size and extent.

It requires little or no imagination to picture the result of an application of stress to such a mass. Unless the large aggregate is very strong indeed, local failure must result at comparatively low unit stress values. Further, even if the large aggregate be very strong, low unit stresses on the mass may result in extremely high stresses on unsupported units with local failure again resulting. One local failure brings other local failures, like a string of dominoes, until the whole mass gives way. It begins to be evident why rock of low strength cannot successfully be used as aggregate, unless conditions of mixing and placing are superior to those that obtained during the making of the wing wall from which this sample was taken.

But the tale has not yet been fully told. It has been seen that the matrix of sand and cement in which the stones are embedded has to transmit stresses. This being true, it follows that the sand grains, as components of that matrix, must each bear a share of such stresses. In the matrix of this specimen, are they bearing the load of which they are inherently capable? Or must they, too, bridge crevasses and pits, as do the stones? The microscope gives the answer.

CHARACTER AND STRUCTURE SAME THROUGHOUT MASS

Fig. 4 is an enlarged photo-micrograph showing a piece of the mortar taken from between the stones of the specimen shown in Fig. 3. This is a characteristic picture of the sand and cement matrix of the average concrete. The photograph was obtained by attaching a camera to the eye-end of a microscope and enlarging the negative obtained, so that the field as seen by the eye is magnified about 25 diameters. In this way the large sand grains are seen as large as the pieces of stone used in the concrete, the small sand grains are of relatively large size, and minute holes, too small to be observed by the unaided eye, appear almost as caverns.

Anyone not accustomed to microscopic work would be unwilling to believe that this figure was other than a direct photograph of a surfaced concrete. There is the same characteristic structure, the same "stones," the same wide separation of aggregate which showed previously why void determinations on stone are unreliable as a basis of proportioning concrete. But perhaps most puzzling of all are the dark masses and particles lying between the sand grains, too small to be sand and also of a different color. Investigation proves them to be *unhydrated cement.* If it has ever been wondered why it was possible to grind up a set concrete and obtain a reset, that wonder now disappears. This unhydrated cement—often as much as 75 per cent of the amount used—lies inert in the matrix, performing no function that might not be better performed by as much fine sand. Evidently the mixing processes are very inefficient. Nor is this an isolated case. No concrete that has yet come under the writer's observation fails to show a large percentage of unhydrated cement. Some of these concretes are more than thirty years old, so that time cannot be said to be the sole determining factor in this regard.

TRAVERSE OF THE MATRIX

The specimen of mortar taken for this micro-examination was cut at random from the chunk shown in Fig. 3. Further, this specimen was surfaced at random, the surface thus obtained being polished with rouge to give proper relief to the various constituents. In area, it did not exceed ½ in. on a side, but the character of matrix found in this area is shown in the nine photographs of Fig. 5. Many more such photographs could have been obtained within this area, but these nine should be sufficiently horrible examples.

With a view to illustrating the working theory before stated, i. e., assuming pure compressive stress and the bridging of air gaps by aggregate, these photographs have been arranged in such position as to make the effect of a vertical stress most evident. Each piece of aggregate in these pictures is a grain of sand, the magnification being about sixty diameters. Many of these sand grains show in Fig. 4 as well, where they can readily be identified by their shape and their relation to other particles determined. Air voids are readily distinguishable, as they show dead-black and structureless, and may further be identified with the aid of the key drawing, Fig. 5a.

In Fig. 5, View 1 shows a sandstone sand grain with an air gap along its lower side and half-way around one end. Contact with matrix is had only on the upper side and at the end not shown.

View 2 shows a quartz sand grain almost completely isolated by air gaps and surrounded on all sides by a honeycomb of air holes.

View 3 shows a sandstone sand grain with a gap below and honeycomb matrix on all sides.

View 4 shows, in an exceptionally beautiful photograph, a quartz sand grain in almost complete isolation.

View 5 shows the large air hole seen in Fig. 4. As a support to even the best aggregate, its value may be questioned.

View 6 shows a quartz sand grain in almost complete isolation.

View 7 shows a limestone sand grain, with a crevasse below and a large air hole at the right-hand end.

View 8 shows a large air hole and some smaller air holes in the cement matrix.

View 9 shows an end of the quartz sand grain and the crevasse seen in View 6, with a large air hole below in the cement matrix.

TESTIMONY OF THE PHOTOGRAPHS

Evidently, from the testimony of these photographs, the cement of concrete not only does not coat the sand and the stone, so that they will stick together, but the sand does not closely fill in between the stones so that they will have proper support. Further, the cement does not fill in between the sand grains, so that they, in turn, will be firmly bedded and be able to withstand the load. Instead of a compact substance, then, concrete is a spongy mass, from one-eighth to one-quarter of which is commonly air and water voids. Yet this specimen under examination was carefully made and placed. What careless field conditions produce is a question worth investigation.

If the steel sold for structural purposes were as spongy and of as uncertain texture as the average structural concrete, steel structural work would be 20 years behind the present mark. The unwisdom of using great masses of any material of low and uncertain strength, in place of smaller sections of proper strength, needs no demonstration.

Yet, if it were desired to aerate thoroughly any fluid, or semi-fluid, substance, no better means could be devised than the present systems of mixing concrete by agitating, churning and pouring, with oftentimes a drop from a considerable height into the form to make undesirable assurance doubly sure.

SUMMARY

Summarizing the previous discussion, it should be noted:

1. That the strength and density of concrete are in direct ratio, one to another; and that for economic reasons, both direct and indirect, concrete should approach the density of natural stone.

2. That the strength and density of any concrete have, as upper limits, the strength and density of the strongest component, usually the coarse aggregate.

3. That the strength and density of any concrete are actually limited by the strength and density of the weakest component, usually the cement matrix.

4. That the cement matrix is not worked at its maximum efficiency, largely because of air and water voids in the mass.

5. That only a small percentage of the cement is hydrated, so that it can perform an active function, the remainder lying inert.

6. That this relatively small percentage of active cement is to a large extent prevented from performing its function of bonding with the aggregate by intrusive films, or bubbles of air.

7. That the pieces of large aggregate and the particles of small aggregate in a concrete are in direct ratio, one to another, at distances approximately equally great, relative to their size; that they are not closely compacted after mixing, as they were when dry, so that void determinations are practically valueless as a basis of proportioning.

8. That because of this wide separation of both large and small aggregate, because of the imperfect contact between cement and aggregate, and because of the weakness of the cement matrix in which the aggregates are imbedded, costly aggregate of superior strength must be used, instead of cheap aggregate of a strength equal to the strength of the cement matrix, in order that these weak spots may be bridged and progressive local failure prevented at low unit stresses.

9. That even with the very best of materials, only concrete of inferior strength is commonly produced.

10. That present methods of mixing tend to aggravate these undesirable conditions.

The preceding discussion has dealt with certain defects in concrete due to entrapped air, but it should not by any means be assumed that entrapped air is the cause of all weak or defective concrete.

On the other hand, it should not be assumed that those weaknesses already pointed out are the only ones traceable directly to that cause. Secondary ills follow the primary weakness in an almost bewildering sequence; and in subsequent papers on microscopic study, which will appear in these columns, an endeavor will be made to touch upon a few of the most important and to indicate means for overcoming them.

The next article in this series will be published in the issue of Feb. 6.

Decline in Iron Ore Production

THE QUANTITY of iron ore mined in the United States in 1914 is estimated to have been between 41,000,000 and 42,500,000 long tons, and the quantity shipped from the mines to receiving ports and iron-manufacturing centers between 39,500,000 and 41,000,000 long tons, according to Ernest F. Burchard, of the U. S. Geological Survey. These estimates are based on preliminary reports from fifty-two of the important iron-mining companies which represent the principal iron-producing districts and whose combined output in 1913 was more than 90 per cent of the total tonnage of iron ore mined in that year. The average decrease in quantity mined by these fifty-two companies was 33 per cent compared with their output in 1913, and if this average decrease should hold for all the iron-mining companies in the United States the total output of iron ore in 1914 should approximate 41,440,000 long tons, compared with 61,980,437 long tons mined in 1913. Coincident with this decrease the iron ore shipped from the mines by the same producers also decreased 33 per cent.

In the Lake Superior district, where about 85 per cent of the domestic iron ore is mined, the average decrease in production was about 37 per cent and the apparent decrease of shipments was about 34 per cent; a drop of 52,518,156 to 32,915,000 and 50,168,134 to 32,790,000 long tons from 1913 to 1914 respectively.

Methylene Test Unreliable with Colloid-Bearing Waters

Serious Mistake Can Be Made by Assuming that Decolorization of Sediment is Measure of Relative Stability

WHEN applying methylene blue to waters carrying colloidal suspensions of clay, the color is adsorbed by the clay and sedimentation occurs, leaving the liquid colorless; the sediment is blue. This adsorption may be only partial; it may take place quickly or slowly, all depending upon the quantity and the character of the colloidal matter present. The adsorption interferes seriously with the quantitative determination desired on the degree of putrescibility of the liquid. In other words, "relative stabilities" obtained in such waters by the methylene blue method cannot be correct, according to Arthur W. Lederer, chemist of the Sanitary District of Chicago. In a paper before the recent meeting of the American Public Health Association in Jacksonville Dr. Lederer said, in substance:

Since the decolorization of the blue color coincides fairly closely with the elimination of the total available oxygen, the oxygen was first determined at the time of decolorization of the liquid and sediment as well. An artificial turbidity of 100 was imparted to a putrescible sewage-water mixture and a number of glass stoppered bottles were filled with this liquid. A number of these bottles were colored in the proper proportion with methylene blue, the others remained as "blanks" for the determination of the residual available oxygen.

CONCLUSIONS

Results indicate the following conclusions: A very serious mistake can be made by assuming that the decolorization of the sediment in silt bearing waters is the correct measure of the "relative stability." Five experiments show that the decolorization lags far behind the elimination of the available oxygen in such liquids or in other words the methylene blue, once adsorbed, is largely inert as an indicator. The adsorbed liquid is, however, not entirely inert, as otherwise the sediment would never decolorize. The fact that the sediment decolorizes only under prolonged ultra-anaerobic conditions makes such an observation useless for quantitative purposes. Reliance on the decolorization of the liquid is equally doubtful because we cannot tell to what extent the decolorization is really adsorption. The methylene blue test in waters carrying colloids is, therefore, of negative value only; that is, if the blue color of the liquid persists irrespective of adsorption, the "relative stability" is 100, or an excess of oxygen may be present.

Dr. Lederer states that he is forced to conclude that it is useless to determine "relative stabilities" in turbid waters by the methylene blue method. To obtain the correct oxygen demand in such waters, he recommends the following procedure:

Determine the initial available oxygen. The free oxygen has to be determined on the spot. A sample for nitrite and nitrate determination can be preserved with chloroform and shipped to the laboratory. Two other samples should be collected carefully to avoid aeration. To one sample add either a certain quantity of fresh water (free of nitrates and nitrites) with a known oxygen content or a definite quantity of saltpeter. Both of these samples are now incubated in closed bottles for ten days at 20 deg. C. At the end of this incubation period, the residual free oxygen is determined in the sample devoid of saltpeter or additional water. The other sample is examined quantitatively for nitrites and nitrates. All figures are referred to one liter of original river water. The nitrite nitrogen multiplied by 1.7 and the nitrate nitrogen multiplied by 2.9 express equivalents of oxygen. The initial available oxygen minus the residual oxygen expresses the biochemical oxygen demand. When the water is very badly polluted, the free oxygen sample need not be incubated for the reason that the free oxygen is certain to be absent after incubation. In connection with these incubations, it is important to keep in mind that the nitrites and nitrates are attacked while free oxygen is still present. As a rule, the nitrites and nitrates begin to be attacked when the free oxygen content is reduced by about 50 per cent.

Not a Life Lost, nor a serious accident, is the record of the Cumberland Valley Railroad for 1914. In a letter to the employees, M. C. Kennedy, president of the road, writes in part as follows: "During the year just closed the Cumberland Valley Railroad transported approximately 8,250,000 tons of freight and 2,000,000 passengers without the loss of life of a passenger or one of its 2100 employees and without injuring a passenger. While there have been minor accidents to employees, not so much as a finger or a toe has been amputated, and with the exception of one fractured ankle, not a leg nor an arm broken. Without taking into consideration the few slight accidents on industrial sidings and in yards there has not been a wreck in the general acceptance of that term. The wreck crew has only been called seven times during the year and the total cost of wrecking has been insignificant."

Chicago's New Tunnel and Pumping Station Part of Comprehensive Waterworks Plan

Part II—Important Extensions and Improvements of System, Seen by City Engineer in 1905, Are Being Built to Serve Needs of Increasing Population

By HORACE S. BAKER
Assistant City Engineer, City of Chicago

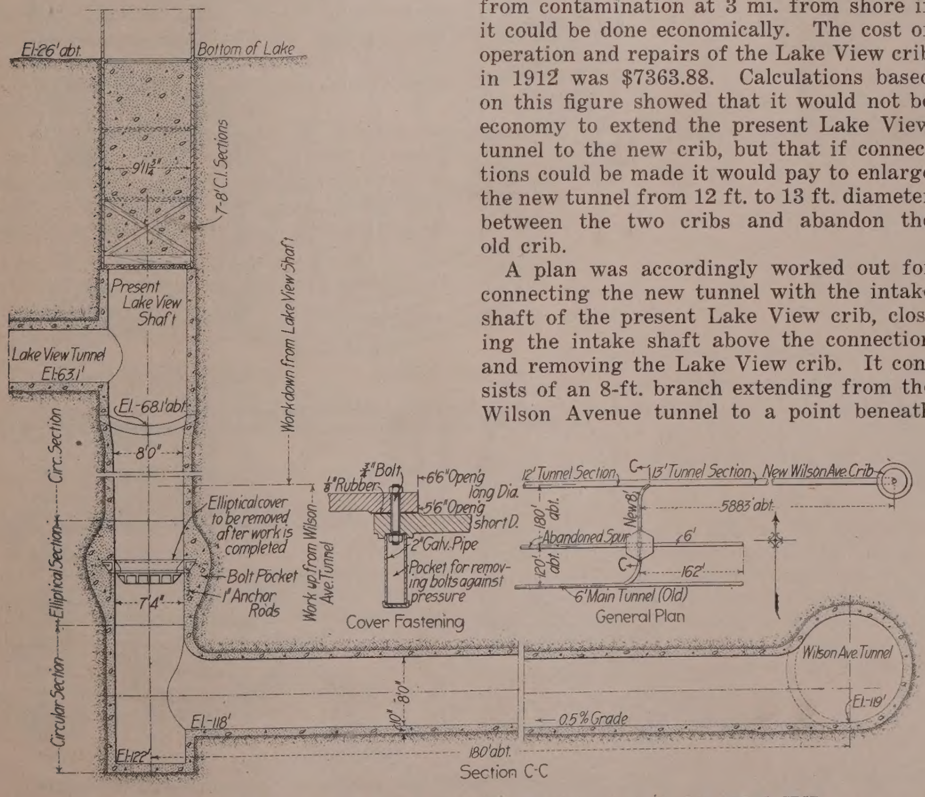
OWING to the comparative shallowness of the water at any reasonable distance from shore, a submerged intake in Lake Michigan on the line of the new Wilson Avenue tunnel was not considered practicable. On this account the gateless crib was designed. Its functions are to protect the intake connection to the tunnel and navigation, to give future access to the tunnel, to screen the water as it enters the tunnel, and to be a possible future sterilizing plant.

The substructure is a type new to the Chicago waterworks, consisting of two concentric steel shells, the outer one of conical shape. It has no bottom, and buoyancy is secured by closing the ports and also by using special flotation cylinders. The steel structure is to be floated to position, sunk by admitting water to the chambers, and the space between the shells concreted. It is expected that the well can be pumped out and the intake shaft sunk in the dry. If it is not possible to pump out the well the intake shaft will be sunk through the water by use of cast-iron cylinders. The arrangement of screens is novel and allows a greater area of opening and lower velocities than when separate gates and screens are used. No gates are provided, but stop logs can be inserted in the screen guides if it shall become necessary to pump out the shaft.

Lake View Tunnel Connection

As the new crib is to be constructed 1 mi. farther out than the present Lake View crib, and nearly in line with it, it appeared desirable to consolidate the two intakes and to secure the advantage of greater freedom from contamination at 3 mi. from shore if it could be done economically. The cost of operation and repairs of the Lake View crib in 1912 was $7363.88. Calculations based on this figure showed that it would not be economy to extend the present Lake View tunnel to the new crib, but that if connections could be made it would pay to enlarge the new tunnel from 12 ft. to 13 ft. diameter between the two cribs and abandon the old crib.

A plan was accordingly worked out for connecting the new tunnel with the intake shaft of the present Lake View crib, closing the intake shaft above the connection and removing the Lake View crib. It consists of an 8-ft. branch extending from the Wilson Avenue tunnel to a point beneath the Lake View intake shaft where a shaft is mined vertically upward to within a few feet of the bottom of the intake shaft. Here it is enlarged horizontally, and a cast-steel ring is concreted solidly in place. A cast steel bulkhead oval in form is bolted to the bottom of this ring near the top of the vertical shaft.



CONNECTION BETWEEN WILSON AVENUE TUNNEL AND LAKE VIEW CRIB

After the new tunnel is full of water and is supplying Lake View pumping station through the Clarendon Avenue connection, the old Lake View tunnel will be pumped out and the intake shaft mined down to meet the vertical shaft above the bulkhead. The bulkhead will then be supported by chains, the bolts removed, and water allowed to fill the shaft. The bulkhead can then be raised by the chains and a concrete plug placed above the Lake View tunnel connection by a diver working under water. The shaft above the plug will then be pumped out to prove the watertightness of the concrete plug, after which the upper part of the shaft and the entire Lake View crib can be removed.

It was decided to make the tunnel 12 ft. in diameter from this connection all the way to Mayfair, with branches controlled by gates at Clarendon Avenue, Lincoln Avenue, Lawndale Avenue and Mayfair. This arrangement will permit of great flexibility in extending the system as the future growth of the city may require.

A circular section was first considered, but a section with nearly vertical sides and flat bottom was decided upon to allow plenty of room for construction purposes.

A concrete lining was recommended by the engineers, but as a concession to former custom in Chicago alternate plans were prepared showing a brick lining. The bids on Section 11 showed that the brick lined tunnel would cost more in every case, and the concrete lined tunnel was adopted.

Borings

Careful borings, made along the line of the proposed tunnel, were extended into solid limestone by means of a diamond drill. All the borings were made by city forces during 1912 and 1913. The average costs were as follows: Borings in Lake Michigan, $15.08 per lineal foot (six borings aggregating 503.4 ft.). Borings on land in 1912, $1.51 per lineal foot (three borings aggregating 473 ft.). Borings on land in 1913, $1.73 per lineal foot (average of all borings made in 1913 including some for bridges, etc.).

It was decided to construct the entire tunnel in rock for two principal reasons. The ground encountered in building the old Lake View tunnel was not favorable for tunneling. The rock rises to such a high elevation farther west that it would not be practicable to pass over it. Furthermore, the rock is of such a character that it is easily mined. It is a dense limestone which breaks out closely to the form desired and is suitable for crushing to use in concrete.

Experience in the construction of the lake section of the Southwest tunnel system had convinced the city engineers that the use of a temporary working crib midway between the shore shaft and the intake shaft was not economical. It was, therefore, decided to construct the lake section without the use of an intermediate crib.

DIVISION INTO THREE SECTIONS

For construction purposes the tunnel has been divided into three sections. Section 1 includes the crib, intake shaft and about 2100 ft. of tunnel. Section 11 extends from the shore shaft 14,000 ft. east and 1 mi. west to Ashland Avenue. Section 111 extends from Ashland Avenue 4 mi. west to Mayfair.

BID PRICES

On June 25, 1914, bids were received for the construction of Section 11. The prices of the low bid were as shown in Table 1.

After careful consideration it was decided that it would be more advantageous for the city to construct Sections 11 and 111 by day labor, in accordance with its general policy of waterworks construction. All bids for Section 11 were rejected and the work has been started by city forces.

TABLE 1—LOW BID PRICES FOR SECTION 11

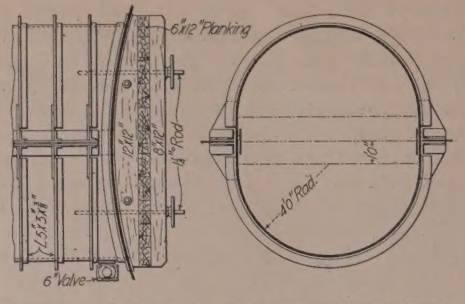
3,753 ft. of 13-ft. tunnel @ $70	$262,710
15,581 ft. of 12-ft. tunnel @ 60	934,860
180 ft. of 8-ft. tunnel @ 45	8,100
32 ft. of 8-ft. shaft @ 80	2,560
Cast steel bulkhead	3,500
Setting gate and mechanism	2,000
Cover on shore shaft	1,500
Lining shaft, 60 ft. @ 25	1,500
Lining tunnel, 1000 ft. @ $25	25,000
Connection to Clarendon Avenue tunnel, 14 ft. @ $100	1,400
	$1,243,130
Pay to city for buildings	500
Total bid	$1,242,630

TABLE 2—LOW BID PRICES FOR SECTION 1

1,312,000 lb. of structural steel @	$0.06
5500 cu. yd. concrete below top of shell @	8.00
465 cu. yd. granite @	60.00
450 cu. yd. concrete above top of shell @	15.00
20,000 lb. reinforcing steel @	0.025
Superstructure complete	42,000.00
Landing structure complete	17,818.00
54 lin. ft. cast-iron lining @	210.00
205 cu. yd. concrete lining of shaft @	12.00
2128 lin. ft. 13-ft. tunnel complete @	77.00

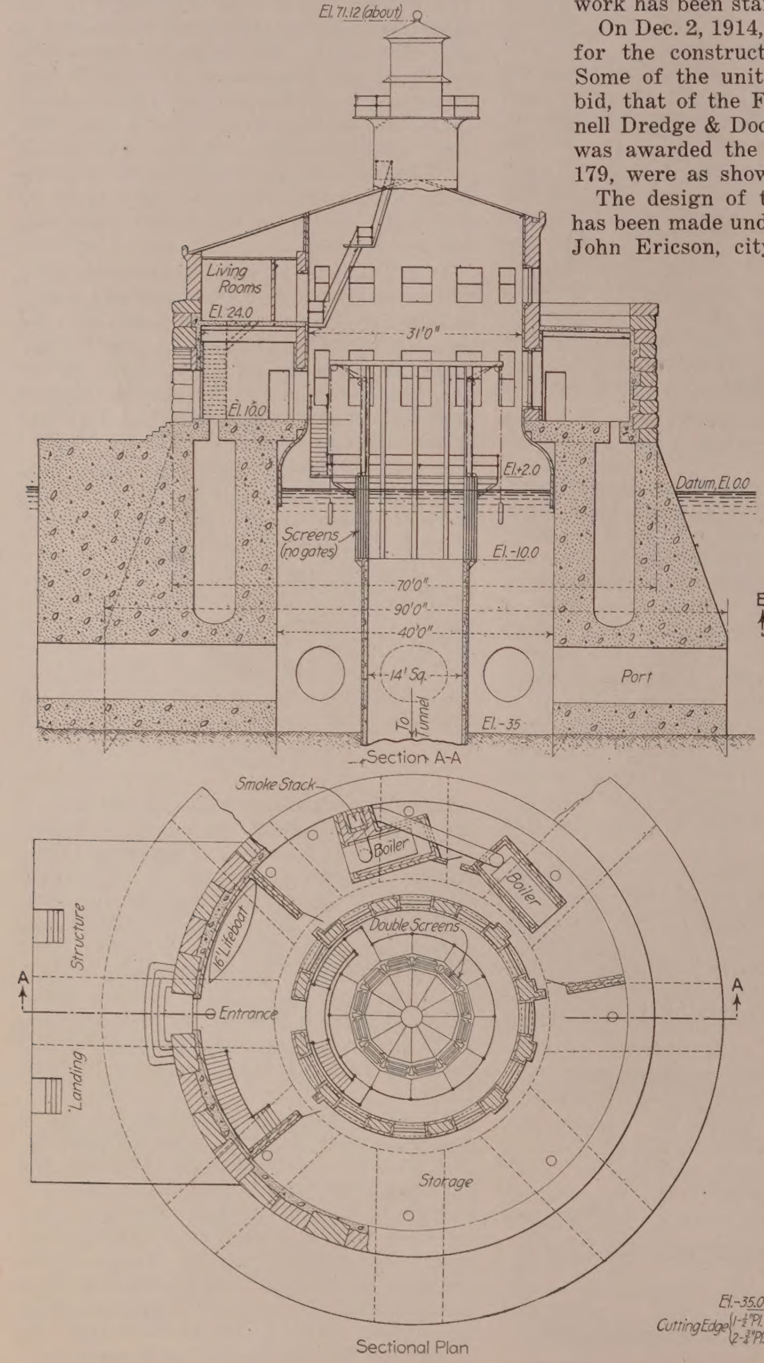
On Dec. 2, 1914, bids were received for the construction of Section 1. Some of the unit prices in the low bid, that of the Fitz-Simons & Connell Dredge & Dock Company, which was awarded the contract at $403,179, were as shown in Table 2.

The design of this tunnel system has been made under the direction of John Ericson, city engineer, M. B. Reynolds, engineer of waterworks design, and the writer. All the construction work, both contract and day labor work, is under the immediate supervision of Henry W. Clausen, engineer of waterworks construction.

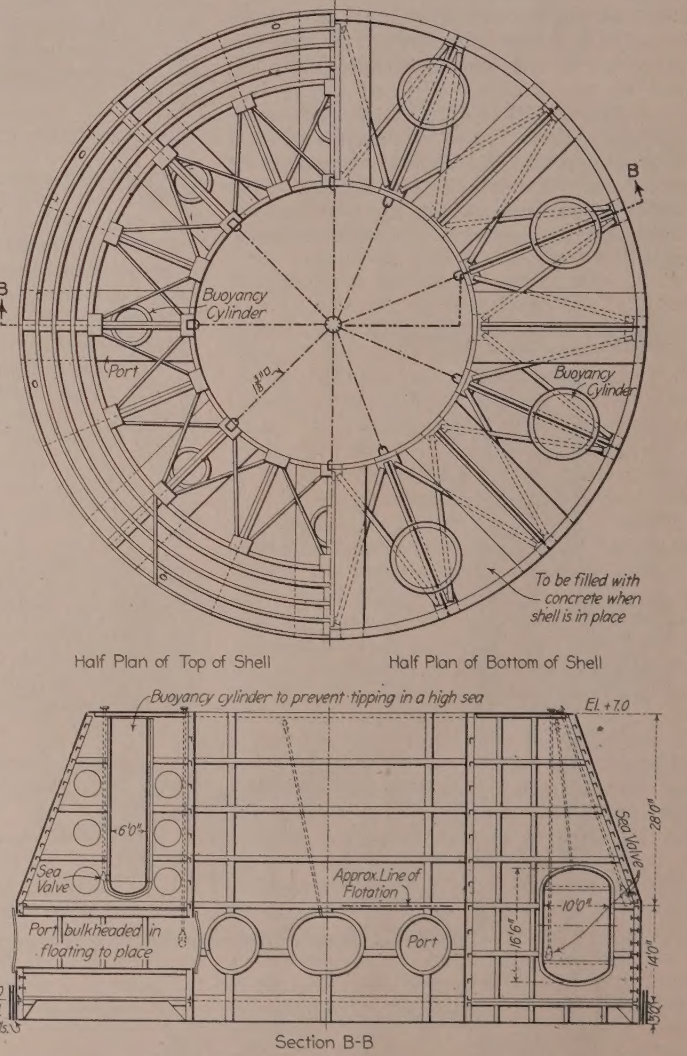


SECTION OF PORT AND DETAIL OF BULKHEAD AT INTAKE CRIB

UNIT COSTS ON GENERAL WATERWORKS JOBS IN DETROIT are given in the latest annual report of the Board of Water Commissioners. Responding to 98 false reports of leaks cost $2.29 each; attending to 466 leaks in service connections, $3.61 each; repairing 204 leaks and breaks in mains, $20.11 each; building 136 wells over gates on old lines, $38.40 each; setting 194 sleeves and valves for services, $18.70 each; setting 11 public drinking fountains, $64.25 each; tapping mains and inserting 3158 1-in. and 5302 5/8-in. cocks for services, $1.35 each.



ELEVATION AND ENTRANCE FLOOR PLAN OF GATELESS WILSON AVENUE CRIB


B
B
Buoyancy Cylinder
Buoyancy Cylinder
Port
18'0"
To be filled with concrete when shell is in place
Half Plan of Top of Shell
Half Plan of Bottom of Shell
Buoyancy cylinder to prevent tipping in a high sea
El. +7.0
6'0"
Sea Valve
Sea Valve
Approx. Line of Flotation
Port bulkheaded in floating to place
Port
10'0"
16'6"
28'0"
14'0"
El. -35.0
Cutting Edge (1-1/2" Pl. 2-1/2" Pls.)
Section B-B

STEEL SHELL FOR SUBSTRUCTURE, SHOWING BULKHEADED PORTS AND BUOYANCY CHAMBERS

American Wood Preservers' Association

Abstracts of Some of the Papers Presented at the Eleventh Annual Convention at Chicago, January 19, 20 and 21—Railroad Ties and Timber for Other Purposes

Sill Ties — Treated or Untreated Timber, or Concrete?

By F. J. ANGIER
Baltimore & Ohio Railroad, Green Spring, W. Va.

SEASONING conditions in tie storage yards vary considerably. One yard may be nicely drained and ballasted; another may harbor conditions which are conducive to the decay of timber. It is fair to assume that there can be found in all tie yards more or less decayed timber, and, generally speaking, this decayed timber will be in direct contact with the ground. To reduce this useless waste of good material resort may be had by placing the ties for seasoning on sills that will not decay. These sills may be of wood chemically preserved, or they may be of concrete.

The tie-storage yard of the Baltimore & Ohio Railroad at Green Spring, W. Va., with the present trackage, provides for the storage of approximately 600,000 ties. This is calculated on a basis of cribbing ties in lots of 100, making four cribs to a pile and 1500 piles. This will require 12,000 sill ties to season the maximum number of 600,000 ties. Every sill tie is in direct contact with the ground.

COMPARATIVE COSTS

Approximately 75 per cent of all ties received for treatment at this plant are purchased as No. 1 ties and 25 per cent, as No. 2 ties. The cost varies in different localities, but we can assume that the average price paid for No. 1 ties is 60 cents, and for No. 2 ties, 40 cents. We believe it conservative to say that 10 per cent of the untreated sill ties check or are damaged to such an extent that they can be used only as No. 2 ties, and that 2 per cent of all sill ties are so broken or decayed as to render them practically worthless.

Using the above estimate as a basis, we may obtain Table 1, and Tables 2 and 3 may be readily prepared. These estimates show an annual saving in using treated sills over untreated of $443.00, and over concrete of $252.00. The cost of concrete sills may vary one way or another, but the estimate shown above is believed to be conservative.

TABLE 1—COST OF UNTREATED SILLS

10 per cent of No. 1 ties, or 900 made No. 2 at a loss of 20 cents each	$180.00
2 per cent of all sill ties are made worthless.	
180 No. 1 at 60 cents each	108.00
60 No. 2 at 40 cents each	24.00
Labor of turning over 12,000 sill ties and cleaning for treatment at ½ cent each	60.00
Restacking yard for locating sill ties	30.00
Disposing of worthless ties	6.00
Cost for six months	$408.00
Cost for one year	$816.00
Interest and taxes one year on 12,000 sill ties ($6,600.00 at 7 per cent)	462.00
Total cost for one year	$1,278.00
Cost per sill per year	0.1065

TABLE 2—COST OF TREATED SILLS

No. 2 ties, each	$0.40	
Cost of treating and laying	0.18	
	$0.58	
Interest and taxes (7 per cent)		$0.0406
Renewal cost (assuming life of 20 years)		0.0290
Annual cost per sill		$0.0696
Total cost for one year		$835.20

TABLE 3—COST OF CONCRETE SILLS

12,000 at an estimated cost of 80 cents each	$9,600.00	
Labor, installing	300.00	
Total cost 12,000 sills	$9,900.00	
Cost per sill	0.825	
Interest and taxes (7 per cent)		$0.05775
Renewal cost (life of 25 years)		0.03300
Annual cost per sill		$0.09075
Annual cost (12,000 sills)		$1,089.00

An indirect saving should be credited to the treated and concrete sills on account of (1) no infection of sound ties from contact with decaying untreated sill ties; (2) less injury to valves and pumps by cinders and other foreign matter carried into the retorts on ties that have been in contact with the ground, and (3) under treatment of sill ties when loaded in same charge with ties better seasoned.

Seasoning of Softwood Ties

By A. H. NOYES

THE SUCCESSFUL handling of softwoods, particularly beech and gum, is a matter that is worthy of serious consideration. The ever-increasing shortage of oak timber of all species makes the adoption of softwoods a necessity, but the character of softwood timber requires careful handling to insure the delivery of sound timber to the treating plant, and thereby a serviceable tie to the consuming road.

Throughout the central section of the United States, and more particularly that part known as a tie-producing region, there is probably a larger acreage of beech and gum than any other tie material except pine; beech is common in most of the bottoms and gum in the low lands, Missouri and Arkansas having thousands of acres of gum that will eventually come in for tie purposes. Owing to the structure of the timber, beech ties are nearly always sawed, being too hard to hew, and on seasoning they get rough or scaly. On the other hand, gum timber hews easily and makes a smooth, pretty tie.

SEASONING AT PLANT PREFERABLE

When gum or beech ties are produced tributary to a railroad, it is advisable that they be shipped into the treating plant as promptly as possible after being made, and seasoned at the plant in preference to seasoning on the line of the road, as, in this event, the ties can be stacked for seasoning under more satisfactory conditions, and can be loaded for treatment at the proper time; in fact, the entire process can be kept under more complete supervision and control than under other conditions, and in this manner the possibility of damaged timber reaching the treating plant can be avoided.

It is an accepted fact that all ties, softwood ties especially, should be carefully piled, never on the ground, but on sound stringers, and that there should be spacing strips between layers, or that they should be piled so that the faces do not have full bearing against each other, as experience has shown that ties piled close soon show damage.

Experience in river territories shows that it is not safe to buy softwood ties while the sap is up, no matter how carefully the ties are piled for proper seasoning, as transportation during the summer is not to be counted on with any amount of security and ties are liable to be damaged before they are loaded for shipment. Besides this, softwood ties piled on river landings are, in some cases, in deep shade, and, when in the open, are frequently surrounded with a rank growth of weeds that tend to hold the moisture, creating conditions favorable to rapid damage. For this reason the practice of buying softwood ties at small landings should be avoided, and ties should be hauled only to landings where they are handled in large quantities, where the timber will be exposed to sunlight and free air currents, where the landings are free from weed growths and where shipments can be made by date rather than by appearance of the timber.

That softwood must and will be used for ties is positive, as the supply of oak is diminishing in quantity and accessibility. That beech and gum make a good tie, when properly handled and properly treated, is an accepted fact, and with an available supply of softwood timber in easy reach of transportation it is desirable that the question be given serious consideration and that the methods and means of handling be freely discussed to promote a more general demand among consuming roads and offset a well-established unjust prejudice against their use.

Mechanical Life of Ties as Affected by Ballast

By EARL STIMSON
Engineer Maintenance of Way, Baltimore & Ohio Railroad, Baltimore

THE WOODEN crosstie, transmitting heavy axle loads from the rail to the ballast, is subjected to mechanical wear not only from the action of the rail on top of the tie, but also from the action on the sides and bottom of the tie of the ballast which supports it. Tie destruction from mechanical wear of ballast seldom occurs to any appreciable extent except in occasional stretches of crushed stone, or other forms of hard-ballasted tracks where a soft roadbed or a sink requires continual raising of track and tamping of ties in order to maintain good track surface. The wearing away of ties by ballast is the result of tamping the ballast under the tie and the action of the tamping tool striking the side and edge of the tie rather than the action of the tie bearing upon and working in the ballast under train loads. There is but little mechanical wear due to the tie working in the ballast.

After ties are first put into the track

and tamped to surface on hard ballast, the necessity for retamping to surface and consequently the wear of the ties by ballast depends largely on the nature of the subgrade. Good surface and subsurface drainage usually insures solid roadbed where the normal bearing value of the material qualifies it for heavy loading. Where such conditions prevail, track surface is maintained with a minimum amount of tamping and the mechanical effect of the ballast on the ties is negligible. Wet cuts and fills, roadbed sinks and side-hill slips produce conditions for which the track as a whole suffers. They are responsible in the majority of cases for bad surface and alignment and can, therefore, be said to be the underlying cause of tie deterioration from mechanical wear of ballast. Such conditions are usually local and the total mileage of roadway involved composes only a small percentage of the total roadway of any railroad system. The removal of the cause, and the restoration of roadway stability in many cases involve heavy expense, for which reason the conditions are often allowed to remain, making necessary the continual employment of forces raising the track and tamping the ties to surface. Thus the roadway conditions are responsible for the excessive tamping and wearing away of the ties.

TIES IN HARD BALLAST

Ties removed after service in hard-ballasted track are found to be pitted or indented on the bottom and sides from contact with the stone or other ballast material. These indentations in the tie are a valuable factor in holding the track in line and surface as long as they are not increased by frequent tamping. The continual tamping of the ballast under the tie soon rounds off the edges of the ties, leaving little or no flat bearing surface for support. When this happens the tie acts as a wedge and tends to force the ballast out into the cribs instead of receiving full support from it.

The greatest wear occurs from 6 to 8 in. either side of the rail, and practically none directly under the rail. In track maintenance the best practice is to tamp the tie for its full bearing on the ballast outside of the rail and for an equal distance inside of the rail. In spite of close supervision, however, this is not always done, but instead the trackman expends his efforts tamping up solid as near the rail as he can work with a tamping pick. This wears off the edge of the tie for some distance each side of the rail and leaves a short unworn edge directly under the rail. When a tie becomes rounded on the bottom at the most essential tamping point and becomes difficult to maintain to surface, it is then found more economical to replace it with a new tie having a flat bottom that will necessitate less tamping. The average trackman feels little hesitancy about removing a tie for this cause when he has difficulty in keeping it tamped. Even in cases of most excessive tamping wear from ballast does not become objectionable until the tie has been in service from 50 to 75 per cent of its normal life.

EFFECT OF KIND OF BALLAST

The kind of ballast and kind of ties used and the standard at which a track is maintained are all important factors in the consideration. Slag and stone, when crushed, form hard, sharp, angular fragments that appear to be more destructive when tamped under wooden ties than gravel, burnt clay, cinders, granulated slag or other similar forms of ballast. Ballast of the last named materials has little or no effect in wearing down the sides and bottom of the ties, nor is the tamping of this kind of ballast so destructive to the ties, as the particles are smaller, generally of softer material and rounded in form. There is a perceptible difference in the resistance offered against mechanical wear by ties made from the different kinds of wood. Hardwood ties of rough texture withstand the action of the rail cutting and of excessive tamping much longer than ties of soft wood. Ties which are most durable under the mechanical wear of the rail also last longer under the wear of ballast—for instance, white oak, chestnut oak, black walnut, maple and beech are more suitable than yellow pine, fir, catalpa, cedar and redwood.

It is important to mention the extent to which some forms of ballast increase the abrasive action of the rail upon the tie. Granulated slag, gravel, cinders, chatts and other forms of ballast carrying fine gritty particles contribute largely to the rapidity of the abrasive action between the rail and the tie or between the tieplate and the tie thus greatly accelerating the mechanical wearing away of the wood. The cutting of the rail into the tie is much greater where fine ballast is used than where coarse hard ballast is used. This trouble has been largely overcome by the use of flanged bottom plates which become embedded in the tie, and by plates fastened directly to the tie by lag screws, independent of the rail spiking, thus reducing the movement between the plate and tie to a minimum.

WHEN TREATMENT IS USELESS

Regarding the use of treated ties where extraordinary wear by ballast is known to exist, the same rule might apply that is observed when the mechanical wear under the rail limits the life of the tie. Treatment to prevent decay does not give the tie increased resistance to abrasion, and ballast abrasion that is so severe as to wear out an untreated tie would preclude the possibilty of any benefit from the use of treated ties at locations where such abrasion occurs.

In conclusion it might be said that the ballast has little direct effect on the mechanical life of the ties. The finer and lighter ballasts, such as gravel, cinders, granulated slag, etc., hasten the rail cutting on the top of the tie by the finer particles working under the rail. The coarser and heavier ballasts, such as crushed stone and slag, bruise and cut into the bottom and the sides of the ties largely under tamping. Comparatively few ties are destroyed from this latter cause, while many more are removed from track on account of the former.

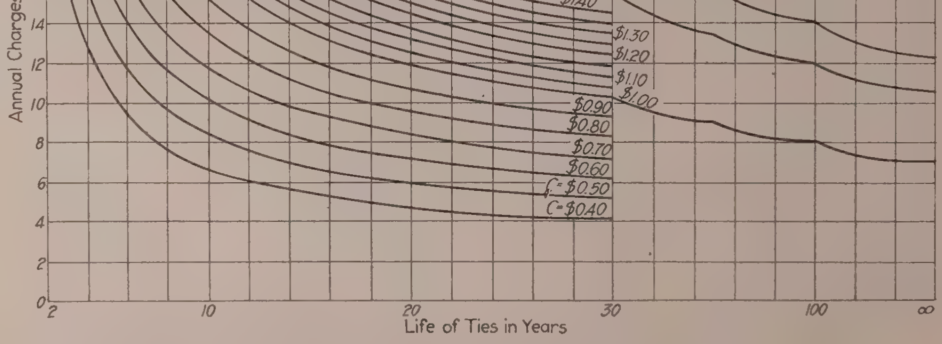
A substantial, well-drained roadbed, and a clean, hard ballast, free from fine particles and coarse enough to insure against holding water, affords the best foundation for the tie—one that will hold to a minimum the "wave motion" of the rail which, aided by the abrasive agent, the fine gritty ballast, so rapidly cuts into the ties, and one that will hold the surface of the track, eliminate the "sinks" and "slides," "pumping joints" with the attendant "pounding" of the ties into the ballast, and lastly the excessive "tamping up."

The desired roadbed condition must usually be made with the materials available, aided by tiling and trench drains. The ballast, however, may be selected. A hard durable stone, crushed in angular fragments, in size from 1 to 3 in., screened free from all dust and dirt, is the ballast that will least affect the mechanical life of the tie.

Justifiable Expenditure for Tie Treatment

By HARRINGTON EMERSON and
T. T. BOWER

SOME items of investment, like an ocean steamer, drag along through a number of years and then are suddenly scrapped. It is proper to set up a depreciation reserve from the first year, of so much per year, to charge this assessment as an operating expense and to earn compound interest on the reserve so that at the end of the life of the steamer there will be a sum sufficient to make good the shrinkage caused by the scrapping. Insurance takes care of total or partial destruction. Other items, like coal, are used up day by day, and are, therefore, charged out when issued, before use, as an



RELATION BETWEEN FIRST COST, ANNUAL CHARGES AND LIFE OF TIE operating expense. There is no interest charge except straight interest on the amount invested in coal not issued. Other items, such as railroad ties, are so numerous, that, like coal, they constitute a constant flow for replenishment. In this case all the ties can be considered as one big tie renewed in part every minute, every hour, every day, the renewal cost thus becoming a monthly charge.

If the ties are worth $25,000,000, 1 per cent for taxes per annum and 6 per cent for interest per annum can be charged monthly against the investment, and in addition there is the monthly charge for the cost of the new ties put in. This method is both safe and rational on an old road on which the inflow of replacement ties has become continuous, but not for a new road with 25,000,000 new ties, expected to last 10 years. In this case a sinking fund would have to be set up, sufficient to replace the ties at the end of 10 years. But ties do not wear out in any such regular fashion. Some go in a year, others last 20 years, and this irregularity vitiates any compound interest plan.

To Determine Annual Cost

To determine the annual cost of maintaining any tie all we need to know is (a) first cost in track, (b) annual interest and tax rate, and (c) life of tie. The first cost of the tie consists of three main charges, some of which may be still further subdivided. The three main charges are: (1) First or wood cost of tie, including foreign freight, preservatives and mechanical protection; (2) labor and other costs of putting ties in the track, and (3) overhead supervising charge. The sum of these is the cost of the tie in track.

On the first cost of the tie there is a tax charge and an interest charge. In our calculations we assume a tax rate of 1 per cent on value and an interest rate of 6 per cent, making a total of 7 per cent. Any other rate can be used. The annual maintenance charge for all ties is the sum of the annual interest and tax on the first cost of all ties in track and the replacement cost in track of all ties removed.

Over a series of years the replacement accurately determines the average life of all ties. If one-tenth of all the ties are replaced each year the average life is running at the rate of 10 years. If in 10 years as many ties have been replaced as the total in service, the average life is 10 years, irrespective of variations in different years.

The annual maintenance cost can be expressed by the formula

$$A = C/Y + C\ (i + t)$$

where A = annual maintenance charge; C, first cost of tie in track; Y, average years of life determined by number of removals; i, rate of interest on investment, and t, tax rate on investment. By means of the above formula the accompanying diagram has been constructed for solving instantly the fundamental question of the relation existing between first cost of tie, life of tie, and annual cost of maintenance.

Three Problems Solved by Diagram

Three distinct problems may be solved with this diagram: (1) To find the relation between first cost and duration of life with a fixed annual cost; (2) to find relation between annual cost and duration of life with a fixed first cost, and (3) to find the relation between first cost and annual cost with a fixed duration of life.

The first problem is by far the most valuable of the three. It solves definitely the economic question of the value of tie treatment. Suppose a tie without treatment costs $1 in the track and lasts 10 years. How much may be spent for treatment to prolong its life to 18 years? The annual cost of a $1 tie lasting 10 years is 17 cents. The intersection of the 17-cent horizontal line with the 18-year vertical line falls on the $1.35 curved line of first cost. Therefore, it will pay to spend 35 cents for chemical treatment or mechanical protection, or both, on the $1 tie to prolong its life from 10 years to 18 years.

The diagram also illustrates graphically, by the steepness of the curves, the great economy in prolonging the life of ties that ordinarily last but a few years.

Protest Against Condemnation of Treated Douglas Fir

By H. E. HORROCKS

OUT WEST beyond the Rocky Mountain barrier you will find the greatest area and quantity of the best all-round commercial timber in the United States, if not in any part of the world; you will find trees growing to an unprecedented size and degree of perfection; and here and there among all these natural advantages you will find a humble representative of the wood-preserving fraternity doing his best for the cause of true conservation, fighting the battle against prejudice and indifference, supplying the material with which all of the Pacific Coast ports are being developed, and trying to convince his fellow-citizen that he can pave his streets with a "silent-everlasting" material, creosoted Douglas-fir wood blocks.

We handle in Douglas fir a timber from which a more diversified product can be obtained than from any other structural timber in the world. We can give you timbers of any workable size. The limit is fixed by structural requirements, not by the size of the tree. Piles 125 ft. long are readily obtainable. Douglas fir is an excellent timber for wood-block pavement and the virtues of that pavement are now being brought home to our western cities. Douglas fir is made into cross arms, wood duct for underground telegraph and telephone work, wood stave pipe, etc. In all of these forms Douglas fir is satisfactorily creosoted on a commercial scale.

Douglas Fir Is Being Treated Successfully

We appreciate and properly value the results obtained from theoretical and practical laboratory research and experimental work, in fact the Associated Pacific Coast Creosoting Companies have in their employ an engineer who had advanced to a position of great responsibility in the U. S. Forestry Department. But when we are told, as in Department of Agriculture Bulletin No. 101, entitled "Relative Resistance of Various Conifers to Injection with Creosote," that Douglas fir is not suitable for creosote treatment, we feel like the man whose lawyer told him he could not be put in jail. The man was in jail for all the valuable advice, and we Pacific Coast creosoters are now successfully treating Douglas fir and have been doing it for more than twenty years past, and we or our successors expect to do it until our forests are exhausted.

We do not believe that the experimental work on which this bulletin is based was sufficiently exhaustive, nor carried out in such a manner as to justify the conclusions arrived at, or the wide publicity given the comparisons made. If this bulletin is to be accepted as of any value to the industry or the user of creosoted material the only possible logical conclusion to be reached from reading same would be that Douglas fir should not be used for that purpose. Such a conclusion, however, would be contrary to actual experience and to the commercial experience of the timber-treating industry on the Pacific Coast. We believe that the conclusions arrived at in that bulletin in so far as Douglas fir is concerned are hasty and that the recommendations are not justified, and we believe the American Wood Preservers' Association should discourage purely theoretical data of this nature. We believe also that the Forestry Department should make it a practice to compare notes with its Western representatives before publishing conclusions concerning a material with which the experimenters are not, in the nature of things, entirely familiar.

Treated Timber for Factory Construction

By F. J. HOXIE

Engineer and Special Inspector, Associated Factory Mutual Fire Insurance Companies

IT IS BECOMING difficult to get timber for mill construction of uniformly good quality with sufficient natural resistance to withstand fungus unaided in the moist atmosphere of textile and paper mills. Longleaf pine of high natural resistance is to be had, but by present selling and grading methods there is frequently mixed with it enough light porous material to destroy the reliability of the lot for important uses. As a result of the poor quality of timber practically obtainable and the higher factory humidities antiseptic treatment of mill timber and planking is becoming a necessity.

Little experience is available to guide the pioneer in the preservation of mill timber. That which has been treated in the past has been used for basement floors, bridges and other construction near or in contact with the earth, where the conditions are somewhat similar to those successfully met in treating railroad ties. The problem of mill frames and floors is different in several respects. Leaching is of little importance. Fire hazard with inclosed rooms containing goods of large value demands the most careful consideration. The strength of the frame supporting a high building filled with processes involving wide variations in temperature and dryness and subject to the constant shock and vibration of moving machinery must be safeguarded against deterioration over long periods of time.

Fewer botanical varieties of timber are practically available for mill construction than for railroad ties. This simplifies the problem, as each variety of tree has its own fungus destroyers. Moreover, the varieties of fungi which attack a given variety of wood are further limited by moisture and temperature requirements, in which most of them are very exacting. It is, therefore, to be expected that only a few varieties of fungi will be found in mill buildings.

The railroad tie in contact with the earth is subject to continuous attack by mycelium as well as spores from fungi flourishing on nearby decaying vegetation. Such sources of infection exist to a much less degree in a building with smoothly painted ceilings and clean floors. As a result, timbers of moderate natural resistance, such as good quality longleaf-pine heartwood without antiseptic treatment, have proved entirely satisfactory for mill construction in the past. It is, therefore, to be expected that much less elaborate preservative treatments than those in use for railroad ties will satisfy the requirements of mill timber.

Destructive Agents

Members of the polyporous family cause much damage to mill roofs and basement floors where excessive moisture is prevalent.

A reduction of the moisture will generally arrest them, but this is not often possible, owing to the necessities of manufacturing processes.

Dry-rot fungi are able to carry on their work of destruction with a much smaller water supply. They have a treacherous resting state and are frequently brought into a building with the lumber. Their rapid growth and destruction of new buildings as well as old, makes them particularly dangerous.

Merulius lachrymans has not been considered common in this country, but from the many widely separated places in which it has been found it evidently is not to be disregarded as a destroyer of structural timber. Probably the chief reason it has been mentioned so infrequently in the past is that timber in common use has had a high natural resistance to it. Fruiting plants of the merulius lachrymans and coniophora cerebella have been found associated with some of the most serious cases of rot investigated. That merulius lachrymans must have the wood prepared for it by coniophora cerebella or some other acid-producing fungus, is the conclusion of Dr. Falck. A regular sequence of fungi on a rotting stump is frequently observed. The study of wood-treating processes should be further simplified by this peculiarity, as it may be necessary to stop only the primary invaders to arrest their followers.

The present methods of handling loblolly and shortleaf-pine timber are disastrous not only to the purchasers, but to the lumber industry. The timber is generally of reasonable strength and would make excellent material for many purposes if kept sound, but the high susceptibility of its broad sapwood to fungus attack makes it an ideal cultivating ground of destructive fungi, with the result that it is not only rapidly destroyed itself, but frequently carries dangerous wood destroyers into buildings previously sound. In one case a mill twenty-five years old, with oak posts and white pine beams, was found in a dangerous condition from dry rot, brought in apparently in boards used for making a temporary floor in the basement. Such timber should be given a suitable antiseptic treatment as soon as possible after it leaves the saw.

How New Lumber Picks Up Infection

The facility with which new lumber can pick up infection, even when handled with unusual care, is almost incredible. I recently received from a Southern lumber manufacturer four samples of short-leaf and loblolly pine which were sawed from the logs in the woods and placed directly on the cars, not associated with other lumber. I received them within a week after they were shipped, and they were bright, with no signs whatever of any form of fungus growth. I placed them in my cellar at an average humidity of about 90 per cent and in the course of a few weeks a fungus growth appeared on the sapwood. This continued to increase during the summer months, the samples having been received in the late spring. In the early autumn fruiting plants appeared. The increasing dryness of the atmosphere arrested them, so that it was not possible to determine the variety with certainty.

If logs can be infected under such conditions, there is little hope for sapwood which after being sawed fresh from the forest is closely piled on cars or in the holds of vessels for a trip of several weeks, later being placed in lumber yards where destructive fungi are almost always present, merulius lachrymans not being uncommon. In one very serious case investigated, there is little doubt that the disease spread from timber to timber while piled in the mill yard awaiting erection. This would undoubtedly have been prevented by a suitable superficial antiseptic treatment of this material at the sawmill.

The combustibility of heavy timber construction with automatic sprinkler protection has not been found to be a serious objection in buildings in which this form of construction has advantages from cheapness, convenience in hanging shafting or comfort of employees. A useful property of importance in paper mills and weaving mills with high atmospheric humidity is the heat insulating power of heavy plank roofs. It would undoubtedly be advisable in many cases to make the roof an inch or two thicker than strength alone requires, with this object in view, as sweating roofs damage goods and are otherwise troublesome. With thick roofs it is absolutely necessary to have lumber which is immune to fungus under the conditions which prevail. If material of sufficient natural resistance cannot be obtained at a reasonable price, antiseptic treatment is imperative.

Creosote and Zinc Chloride

Coal-tar compounds are not generally adapted to factory construction, owing to the black, greasy surface which they leave, their somewhat disagreeable smell and chiefly the increased fire hazard. In a recent fire the Factory Mutual Fire Insurance Companies paid a loss of about $60,000 on a paper mill where a coal-tar compound had been used on the roof planks. Those who were present at the fire stated that this compound undoubtedly contributed much to the loss in rapidly spreading the fire over the entire roof.

A paper by H. M. Rollins entitled "Inflammability of Treated Timber," together with the discussion in the 1910 proceedings of this association, indicates that railroad ties and telegraph poles that have been creosoted are rather less combustible than those which have not. A part at least of this apparent fire resistance can be accounted for by the fact that the sound wood of the preserved material is considerably less combustible than the punky wood of that which has been attacked by fungus. The rapid escape of the heated gases from the immediate neighborhood of the burning material is also a factor with fires in the open air. Conditions in mill buildings are quite different. The closed rooms can retain the heat generated by the burning oil, rapidly raising the temperature to the ignition point of the wood, extending the fire and increasing the water and smoke damage to the contents.

Zinc chloride has, so far as I am aware, been used in mills to only a very limited extent and practically no data are available as to its value. The suspicion that it may gradually decrease the strength of the timber over long periods of service or when subjected to elevated temperatures would cause it to be regarded with disfavor until further proof of its harmlessness is forthcoming.

Corrosive Sublimate

Corrosive sublimate has been used somewhat in the past with good results. Little experience is available as to its serviceableness when applied to mill timbers, although basement floor planks, fence posts, parts of bridges, etc., are in use about the Lowell mills, which have been treated with it at various times within the last sixty years and are reported to have given satisfactory service. A paper presented at the last annual meeting of this association by Dr. Frederick Moll states that wood treated with corrosive sublimate is in extensive and successful use in Germany and Austria. Malonkovic regards corrosive sublimate as an effective wood preservative when applied in an open tank with comparatively little penetration, owing to its high toxic power and to the fact that it forms an insoluble compound in the wood cells which make it permanent.

For treatment of mill timber an inexpensive process which can be applied on the job after the timber is cut to final shape has many advantages. In several cases where timber has recently been so treated with corrosive sublimate the cost and convenience have been very satisfactory.

From the limited information thus far available the corrosive-sublimate process appears to be best adapted to the general requirements of mill timber. Fluorine compounds have shown good results in laboratory experiments but no practical experience with them is available. The cheapness of chloride of zinc or sodium fluoride would not give them a great advantage over corrosive sublimate, as the cost of the chemicals is a comparatively small item in either case, when used in open tanks, and would be easily compensated for by the greater toxic power of the mercury salt.

In conclusion, there is no doubt that the value of the mill timbers which rot each year is a sufficiently large sum to make preservative treatments well worth while. When the problem is narrowed down to the conditions of moderate exposure in the mills the few woods available for mill construction and the few fungi that commonly destroy them, it is probable that a reasonable cheap and convenient process such as corrosive sublimate in an open tank will satisfy all requirements if applied soon enough. Probably a light treatment at the sawmill and another after the wood is cut to final shape and ready to be put in place in the mill frame will be found most serviceable.

In Planning Highways in Ohio, according to John Laylin, division engineer of the State highway department, in a paper before the American Road Builders' convention, an effort is made to secure a clear-sight view of at least 300 ft., a maximum gradient of 8¾ per cent, and a drainage system that will maintain a water level well below the base of the foundation of the pavement.

The Collection and Use of Stream Discharge Data in Pennsylvania

Gaging Methods Employed by State Water Supply Commission—Difficulties Encountered in Winter—Flood Warnings—Application of Results

By R. A. BOEHRINGER
Assistant Engineer, Water Supply Commission of Pennsylvania

FLOOD data on Pennsylvania streams, obtained by the Water Supply Commission of that State, have made possible not only an accurate tracing of flood crests, but also reliable computations of the maximum rate of flood run-off and the total volume yielded. The commission operates directly, or receives information from, 86 gaging stations distributed over the four main river basins of Pennsylvania—the Delaware, Susquehanna, Potomac and Ohio.

Gage Readings and Records

Weekly report cards are received from the observers, who read the gage heights usually twice daily at each station; and measurements of discharge are made at frequent intervals by hydrographers of the commission. Using gage heights as abscissæ and second-feet as ordinates, discharge curves are drawn for each station. Large and small Price current meters are used in this work, although in cases where flood velocities are very high small meters with pentameter heads have given better service than the large meters.

Measurements of velocity are taken preferably at two-tenths and eight-tenths of the depth and, as conditions may require, at six-tenths of the depth or at the surface; the integration method is used in some cases during low water and when the channel is bad. During high stages surface measurements only, as a rule, are taken, and, according to the velocity and depth of water, a coefficient varying from 0.88 to 0.95 is applied.

In selecting a gaging station for measuring the flow of a stream, a bridge is chosen which most nearly meets the requirements of having a smooth flow over a permanent bed between well-defined banks high enough to confine the maximum floods, and which, at the same time, has a measurable velocity at all stages. It is generally difficult to secure an ideal station, and the process of elimination must be used to obtain the best available. If it is necessary to select a bridge which is not truly normal to the current, the observed discharge is reduced by multiplying it by the cosine of the angle.

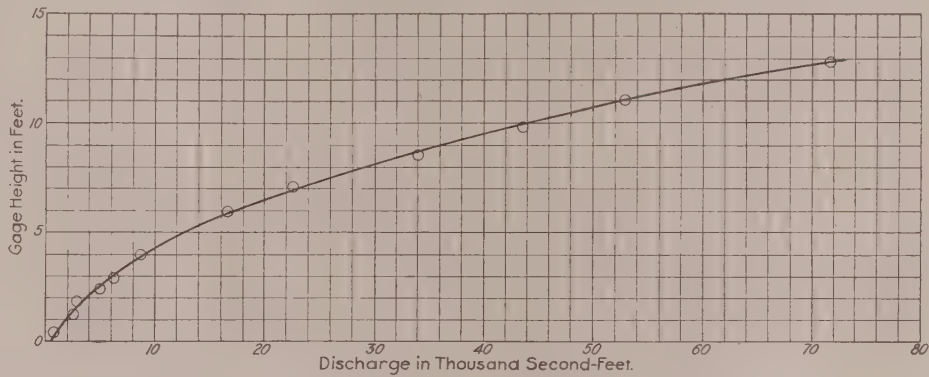
Types of Gage

There are three kinds of gages used in this work, the common staff gage in all its modifications, the chain gage and the Mott gage. In addition, several dams are used as weirs. It is the intention, however, to adopt self-recording gages when one of proven quality, durability, and accuracy is found. Each gage is referred to a permanent bench-mark and levels are run over them twice annually. Staff gages, unless moved by ice or débris during floods, seldom change their position, since they are securely fastened to masonry abutments or piers. The chain and Mott gages, however, are subject to considerable changes of elevation, and corrections must invariably be applied. The errors in the latter gages are either of chain stretch, which in some cases is considerable, or of changes in the level of the bridge itself, or the gage box on the bridge. The chain and Mott gages are usually attached to the handrail or floor near the middle of a span, and the elevation may change due to the settling of the bridge or gage, to temperature changes in the bridge if it is a steel structure, and to various minor causes.

In measuring the discharge of a stream, the meter is usually suspended by means of a cable from a bridge, although during periods of low flow wading measurements are nearly always taken. In Pennsylvania, where industries and agricultural life are well developed, bridges are nearly always available for the establishment of a station and for this reason no cable stations across streams have been erected for the measurement of discharge. In taking a measurement vertical velocity sections are recorded at intervals and the mean velocity, V, is computed from the formula

$$V = \frac{CV' + (V'' + V'''')/2 + V'''}{3}$$

where V' = surface velocity; V'' = velocity at two-tenths of the depth; V''' = velocity at six-tenths of the depth; V'''' = velocity at eight-tenths of the depth; C = constant varying from 0.88 to 0.95 according to the depth, width, and velocity of the stream.



RATING CURVE, WEST BRANCH OF SUSQUEHANNA RIVER AT RENOVO

Observations in Winter

During the winter months many of the streams become ice-bound and it is then difficult to obtain accurately the stream discharge. The observers are instructed to read gage heights to the top of the water as it rises in a hole cut in the ice, and the gage heights of the top of the ice together with its thickness. Some discharge measurements have been made by cutting holes through the ice, at intervals of 5 and 10 ft. in a section across the stream at the gaging station, and taking depths and velocity observations with the meter at each hole. These measurements, plotted on the curve of open channel flow, usually show large differences in the discharge of the ice-bound and open channels for the same gage height, the latter invariably being the larger.

In arriving at the discharge of a stream for an ice period which, in some cases, may extend over an interval of three months, a number of considerations influencing the discharge are considered. In the first place, the gage heights do not represent those equivalent to open channel conditions, while ice gorges and jams below the gage may cause back-water and raise the gage height in excess of that which would otherwise have occurred. Considering these conditions, the gage heights may therefore be taken only as a rough guide for the discharge of a stream during the frozen periods. If a neighboring stream is open, the run-off in second-feet per square mile of the open stream may be applied to the drainage area of the ice-bound stream and the total discharge thus obtained. On the other hand, when all streams are frozen, as was the case for over two months during the winter of 1911-12, recourse must be had to a general inspection of the gage heights and the climatological records of the U. S. Weather Bureau. If meter measurements have been made during the frozen period, the accuracy of the necessary estimates is increased. By applying the necessary correction to the gage heights observed during the frozen period, and by observing the climatological records during the same time, estimates of discharge may be made to approximate the actual amount of water flowing down the stream. When rivers are frozen solid the flow is seldom large and errors in estimating the discharge will generally be a small percentage of the yearly yield.

The data collected in this class of work are finally computed in terms of the run-off in second-feet per square mile of drainage area above the gaging station, and it is, therefore, important to obtain the area of each watershed accurately. Where the U. S. Geological Survey has mapped a region, such drainage areas may readily be obtained, but where these sheets are lacking, reliable maps are often difficult to obtain. In Pennsylvania, one of the original thirteen colonies and one of the most highly developed States of the Union, approximately 60 per cent of its total area has not yet been mapped by the U. S. Geological Survey.

In addition to the trouble experienced in ascertaining correct drainage areas, it is often difficult to obtain competent observers to read the daily gage heights on account of the limited funds available for their compensation. For the same reason the commission cannot make its own surveys for the determination of drainage areas. The work is also interrupted in some localities by the theft of the gage chains and by the malicious demolition of gage boxes and boards.

Stations are so located on the main rivers that the relation existing between flow of the main stream and its tributaries may be determined. As an example of this, the station at Harrisburg may be cited as representing the flow from all that country drained by the Susquehanna, the Juniata and the North and West Branches of the Susquehanna River. Above Harrisburg the commission operates twenty-seven stations on the main river and its tributaries, five on the Juniata River, eighteen on the West Branch and four on the North Branch. By a study of the fluctuations in the flow at Harrisburg, changes in the gage height and discharge may be traced directly to those sections of the State contributing to the run-off at this point. Thus notable errors in the determined flow of contributing streams are often found and corrected.

FLOOD WARNINGS

On account of an act passed in May, 1913, by the Legislature of Pennsylvania, an extension of the stream gaging system has been required. This act provides that "the commission shall, during freshet and flood conditions, issue bulletins to be telegraphed or telephoned to such municipalities in the Commonwealth where flood damage is likely to be caused, forecasting the probable maximum gage heights expected to be reached and the probable time of the arrival of such gage heights."

In carrying out the provisions of this act the first step has been taken along the Susquehanna River and its West Branch, and the system of reporting to the main office changes in gage heights and temperature, together with the amount of precipitation, has been elaborated. In addition to the 28 original stations in this basin, 11 new ones have been established during the past summer, and the flood warning system is now in active operation. Contractors, engaged in working along the Susquehanna River, have filed requests for warnings of specific gage heights and, during the moderate rise in the river which occurred the latter part of October, 1913, the commission, by its timely warnings and predictions, saved for the contractors over 30 per cent of the amount ($10,000) especially appropriated for the next 2 yr. for the flood warning work. It is proposed to extend the flood warning system gradually over the entire State, and much valuable aid will undoubtedly ensue for the prevention of loss of life and property in the many localities subject to floods.

DISCHARGE CURVES

Tables of discharge are computed from the discharge curves for the observed range of gage heights, from which daily and monthly discharge sheets are made, showing the mean, maximum and minimum flow to three significant figures, together with the run-off in second-feet per square mile and the run-off depth in inches.

The discharge curves for each station change from year to year. This is caused by a cutting out by natural erosion or a filling in by sedimentation of the channel at the gaging station, the former producing an increased flow for a certain gage height, and the latter a decreased flow for the same gage reading. Soundings by means of a wire and weight are taken at each station twice every year. As meter measurements are taken from time to time, these changes in the discharge of a channel are detected and a new curve is drawn, or the old one altered to conform to the new conditions. During periods of unusually high water measurements of discharge may be obtained at gage heights never previously reached and these measurements, when plotted on the discharge curve, may cause a material alteration in the curve and a consequent change in the data previously computed.

The latter condition was realized during the last great flood when the commission obtained thirty-nine discharge measurements, rendered possible by the absence of ice, the breaking up of which is the usual accompaniment of high spring floods. Some of these measurements, obtained at unusual flood heights, completely changed discharge curves, requiring a consequent revision of former computations. As an index of the unprecedented heights attained by some of the rivers, it may be remarked that the Shenango River at Sharon was 3.5 ft. higher than its previous maximum and the Allegheny River at Franklin rose 0.5 ft. higher than the great flood of 1865, which, hitherto, had been unsurpassed in the annals of flood records of that vicinity.

APPLICATION OF RESULTS

The results of these stream discharge operations are applied to many uses throughout the State, among the foremost being the use of the data for stream flow regulation by means of storage for power development or domestic water supply. The relation between run-off and rainfall should not be omitted in an enumeration of the applications of the collected data, since this relation is used in evaporation studies for storage reservoirs.

The Water Supply Commission has completed the compilation of a mass of figures and other information relative to the stream flow throughout the State. This report forms a comprehensive, authentic and valuable record of the discharge of rivers and streams throughout the State of Pennsylvania, including the full record of each stream which has been measured. It is proposed to publish annually in the future the complete stream flow data for the preceding year.

Decay of Wood Pipes

Staves, Rather Than Bands, Usually Determine Life of Pipe—Asphaltum or Tar Coating Protects Both Bands and Staves

THE LENGTH of life of wood pipe is dependent on the life of the wood staves rather than on the life of the bands, although contrary theories were held 30 years ago, according to Bulletin 155 of the U. S. Department of Agriculture, from which these notes are taken. Only in rare instances have the bands failed first. Corrosion of the bands, being a chemical action, requires the presence of moisture and oxygen. It usually occurs most rapidly where pipes are buried and the backfill is wet under conditions which, as a rule, are most favorable for the life of the wood. Corrosion is greatly accelerated by the presence of alkali in the soil.

The decay of wood pipe is due primarily to the growth of fungi, though possibly certain forms of bacteria may assist in the final destruction of the wood cells. The growth of fungi to an extent detrimental to the life of the wood requires a favorable combination of moisture, air and heat. The exclusion of any one of these beyond certain limits prevents their growth.

PIPE CONTINUALLY SATURATED LIVES LONGEST

It follows that with pipes buried in the ground the wood will endure longest where the air is most nearly excluded, either by a high internal pressure which completely saturates it, or by a deep covering of very fine soil. In accordance with the foregoing statement experience shows that in contact with the soil wood pipe decays more rapidly under a light head than it does under heavy pressure, and other things being equal, it usually decays more rapidly in a porous open soil, such as sand or gravel, than in a fine soil of silt or clay, because the finer soil is more effective in excluding the air. Experience appears to indicate also that wood decays more rapidly in a loamy soil, rich in humus or partly decayed organic matter, than it does in one containing little or no humus. This is probably due to the fact that the presence of organic matter affords more favorable conditions for the development of fungus growths and bacteria.

Pipes fully exposed to the atmosphere and free from contact with the soil will, as a rule, be too dry on the exterior to favor the development of fungus spores, and so long as the outside of a pipe remains dry no appreciable decay will occur, even though the internal pressure is very light. Decay of exposed pipes almost invariably starts at the ends of staves, as a result of leaky joints. Where water leaks out and runs down over the outside of the pipe favorable conditions are afforded for the growth of algæ; then mosses may begin to grow in the soil that collects on such spots, and decay spreads to adjoining staves. Bruising the staves in handling or injuring them by too tight cinching of bands renders them more susceptible to infection by the spores of wood-destroying fungi, thus hastening decay. The life of exposed pipes may be prolonged by promptly stopping all leaks as they develop and by keeping the exteriors dry. The decay of buried pipes has also in some instances been arrested by removing the covering and leaving them exposed.

PROTECTIVE MEASURES

The asphaltum or tar coating applied to machine-banded pipe, while intended primarily as a protection against corrosion of the bands, doubtless helps also to some extent in preserving the wood. Until recently the practice has been to leave the ends of wooden sleeve couplings untreated. These couplings almost invariably decay long before the main pipe. This may indicate that infection by wood-destroying organisms starts principally where the coating is absent, though less perfect saturation of the wood in the sleeves may be the more largely responsible for the early decay, as it may also be noted that decay occurs at summits of pipe lines, where air accumulates, much sooner than at depressions.

The practice of coating continuous stave pipe has not been common, but in a considerable number of cases some treatment has been applied for the purpose of preserving the wood. There is wide difference of opinion as to the value of such treatment, and the effectiveness for the purpose intended may also depend greatly on what is used and on how and when it is applied.

On exposed portions of new pipes the U. S. Reclamation Service has used a paint consisting of 6 lb. of red oxide mixed with 1 gal. of boiled linseed oil. One gallon of the paint was sufficient for two coats on 125 sq. ft. of pipe. On the top of the pipe, where it is exposed to the sun and where water from leaky joints runs down over it, this paint does not last long, much of it being gone in two years. Repainting while the pipe is in use is usually not practicable, because oil paint will not adhere readily to wet material. The use of paint on exposed pipes under ordinary conditions probably adds very little to their life.

Costs Reduced by Monolithic Curb, Gutter and Pavement

Economies Effected in Middle West by Integral Curb Construction Which Added Only Few Cents per Yard to Pavement Cost

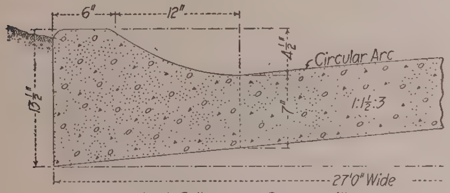
BY CASTING concrete curbs, gutters and pavements as monoliths the cost of highway and suburban road construction in the Middle West has been considerably reduced. Typical cross-sections of the various designs are shown herewith. The reason usually given for including the curb with the pavement is the greater economy over the usual type of curb and gutter, the cost of which runs from $3500 to $5000 per mile. The bid cost on curbs often bears little or no relation to the actual cost, but is largely a matter of custom. Integral curbs add but a small amount in yardage of concrete, and the cost, depending on the type, should not be more than one-fifth to one-tenth of the above figures. Distributed over the total area of the pavement there is added but a few cents per square yard to the pavement cost.

CARPENTER BRACES ARE USED TO HOLD FORM BOARDS AGAINST SPACERS

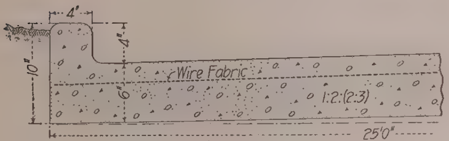
Of the various types those used in Glencoe and in Highland Park seem to be the ones more generally favored for suburban pavements. Where a former macadam road existed and the parking was sloped down to meet the pavement at the lowest point, the Winnetka type has worked out well. With reinforcing in the slab it is usual to place the concrete in two layers, adding the curb with the second coat. Carpenter braces are used to hold a form board against spacers, as shown in the photograph of the Highland Park work being carried out by H. G. Goelitz, contractor. On flat grades the curb height varies between inlets from 2 to 8 in.

Where the pavement is laid in one course some form of curve gutter is used, as exemplified in the Geneseo and Winnetka sections. The strike board is then cut away to give the proper shape. In the Highwood job the cinders were rolled into a rather soft subgrade to stabilize the foundation.

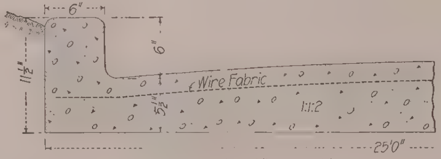
MOTOR TRAFFIC in Massachusetts has shown a striking increase in the last ten years, while horse-drawn traffic has not changed materially, according to figures presented at the recent convention of the American Roadbuilders' Association by A. W. Dean, chief engineer of the Massachusetts Highway Commission. In 1906 there were 7327 motor vehicles registered in the State, while in 1910 and the four years following the numbers were 34,665, 44,000, 56,000, 70,000 and 84,000 respectively. The ratio of motor trucks to vehicles is also increasing. In 1912 it was 7 per cent and in 1913 and 1914 it was respectively 8 and 10 per cent. The capacity of trucks has been increasing rapidly, and unless legislation is soon started no roads now constructed can stand the wear. In the Liverpool docks are the heaviest trucks known, weighing 30 tons. In Massachusetts recent legislation has been passed to restrict this tendency to develop heavier traffic. Among many other restrictions is one that no loaded trucks of total weight of more than 14 tons may traverse the roads without first obtaining a permit, and unless the street is paved with the more substantial hard surfaces, weights per 1-in. width of tire are to be restricted to 800 lb. Limits are also placed on the speed.



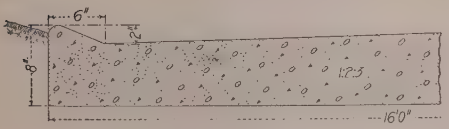
North College Ave., Geneseo, Ill.



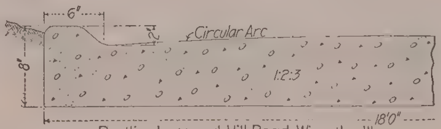
Thirty-fourth Street, Indianapolis, Ind.



Kimberly Ave., Kimberly, Wis.

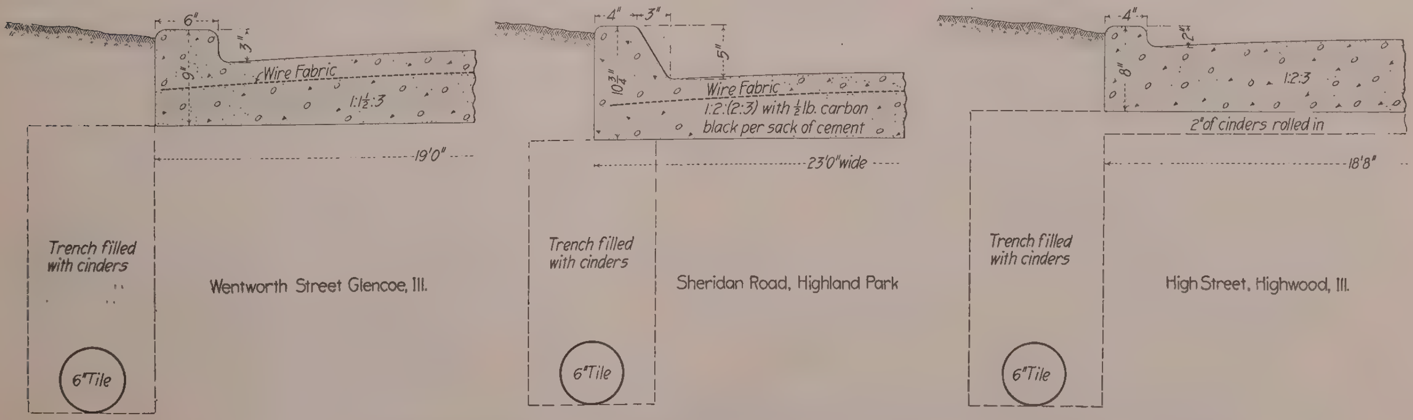


Indian Hill Driveway, Winnetka, Ill.



Bertling Lane and Hill Road, Winnetka, Ill.

TYPICAL CROSS-SECTIONS OF INTEGRAL CURB AND PAVEMENT


6"
3"
9"
Wire Fabric
1:1½:3
19'0"
Trench filled with cinders
Wentworth Street Glencoe, Ill.
6" Tile
4"
3"
10½"
5"
Wire Fabric
1:2:(2:3) with ½ lb. carbon black per sack of cement
23'0" wide
Trench filled with cinders
Sheridan Road, Highland Park
6" Tile
4"
2"
8"
1:2:3
2" of cinders rolled in
18'8"
Trench filled with cinders
High Street, Highwood, Ill.
6" Tile

DRAINAGE PROVISIONS AND DETAILS, SHOWING VARIATION IN PRACTICE AT THREE ILLINOIS CITIES

Tower of Jewels at Exposition a 435-Foot Skyscraper on Two-Hinged Arches

Design of Lofty Steel Framework Required Careful Analysis of Wind Loads—Main Frames Are Supported on Spherical Cast Steel Bases

By FRANK S. M. HARRIS
Assistant Structural Engineer, Panama-Pacific International Exposition

RISING to a height of 435 ft., and overtopping surrounding domes and arches by 250 ft. or more, the Tower of Jewels fulfills its function as the dominating feature of the architectural scheme of the Panama-Pacific Exposition at San Francisco. To an elevation of 152 ft. above the ground the walls of the tower rise vertically, forming a cube, 120 ft. square in plan, the cube being pierced in a north and south direction by a barrel arch, the soffit of which is 119 ft. above the court. The clear height of the vault is notable and is made possible by two-hinged arches measuring 126 ft. from the bottom hinge to the center of the lower chord. Above the top of the cube the structure consists mainly of a series of cylindrical portions of variable and rapidly decreasing diameter, composed of balustrades, colonnades and heavy belt courses. The outstanding ornament upon these upper decks is elaborate. The structure gains its name by the studding of its exterior with thousands of cut-glass "jewels" which, in the bright sun or under the searchlight beams at night are expected to present a brilliant and dazzling spectacle.

The main steel frame of the tower supports an exterior shell of timber, plaster and staff. The great rectangular box, below El. 152, as well as the flanking colonnades are self-supporting timber structures, slightly tied back to the steel frame. The coffered ceiling of the barrel vault is suspended from the steel arches. Above the rectangular section, the successive decks are carried upon timber brackets resting in seats provided on the steel frame and secured to it by rods and clip angles. Upon these decks are framed the walls and outstanding ornaments of the tier above.

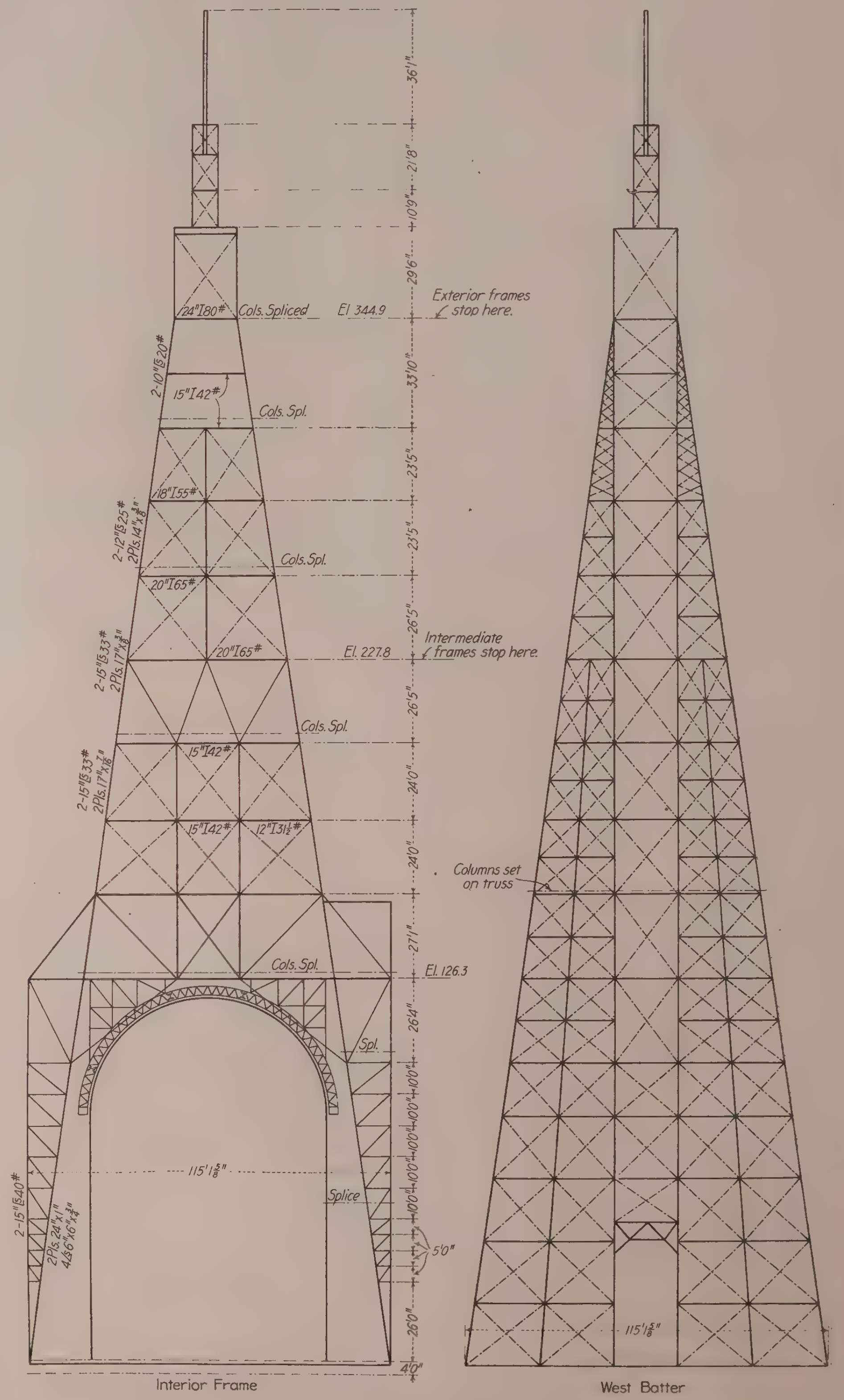
STEEL FRAME

The steel structure consists mainly of six frames, parallel to each other in plan, two of them vertical, the other four battered. The two vertical frames, designated as the interior frames, rise to an elevation of 364 ft., being 20 ft. center to center, throughout. Two exterior frames are battered so as to meet the vertical interior frames at El. 335. The intermediate frames also batter at half the rate of the exterior frames, and if produced would also intersect the interior frames at El. 335. The intermediate frames, however, are discontinued at El. 228, to simplify the construction. Above El. 335 all columns are vertical.

Below El. 152 the six frames are constructed as two-hinged arches with elastic ties, their feet resting on twelve cast steel spherical bases, which are in turn supported upon reinforced concrete slab footings, capping pile clusters.

Cross-bracing is introduced between the six frames, both in the planes of the main batter posts and in the planes of the lower vertical members of the main arches, from El. 126 to the ground. Bracing is further provided in the planes of the knee braces and the hip members of the arches. Horizontal bracing is placed at 20-ft. intervals, vertically, in the lower legs of the frame, and at approximately 25-ft. vertical intervals, immediately below the floors, throughout the upper reaches of the frame.

The exterior walls consist only of staff and plaster on metal lath, spiked to the studding and furring timber. With the exception of a loose plank floor at El. 152, intended to protect the main plaster arch from injury by falling objects, there are no complete floors in the building, the several decks extending but a few feet inside the exterior walls. Inasmuch as spectators are not to be permitted within the tower, even these floor systems were considerably lightened in the design. A live load of 50 lb. per square foot was taken to insure stiffness, but was not carried into the column investigations. There are no interior partitions. The staff was taken at 25 lb. per square foot, including the timber backing sticks, though not the main studding of the walls. Plaster on metal lath was taken at 25 lb. per square foot.



FRAMING OF STEEL TOWER OF JEWELS, FRONT AND SIDE ELEVATIONS

The dead loading was, therefore, quite definitely known, and, with the estimated weight of the steel itself, could be combined with the wind loads, as described later, and carried to the next level below.

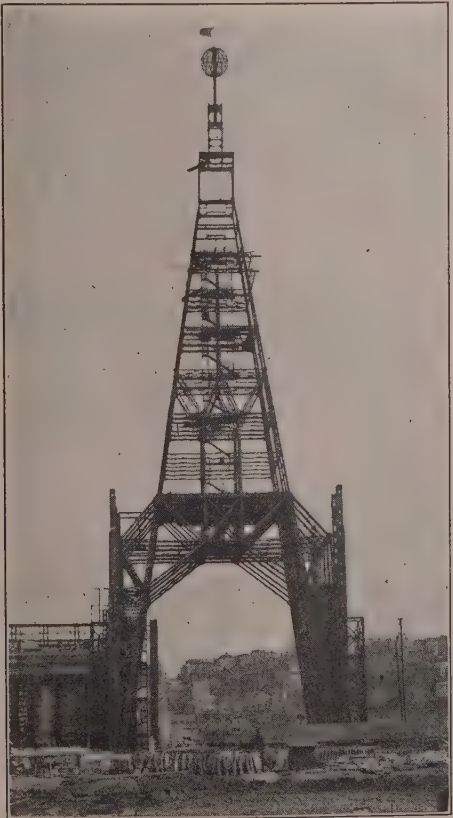
The wind load, as used, was 24 lb. per square foot of vertical projection. Wind concentrations were then determined for the several levels, the wind between panel points on the steel frame being carried equally to the floors above and below by the wall studding. The wind loads thus concentrated at the floor levels were distributed among the several frames. Two cases were considered—wind parallel to the main frames and perpendicular to them. Having the panel point concentrations for the main frames, in accordance with the above assumptions, a graphical stress diagram of the usual form was carried through.

Below El. 152, the main frames were considered to act as two-hinged arches, carrying the vertical and horizontal loads from the structure above as concentrations on their upper chords at the points of the column connections. About the east and west axis of the tower the stresses and, therefore, the frames are symmetrical, requiring three types of frame, two in each type, designated respectively as the exterior, the intermediate and the interior.

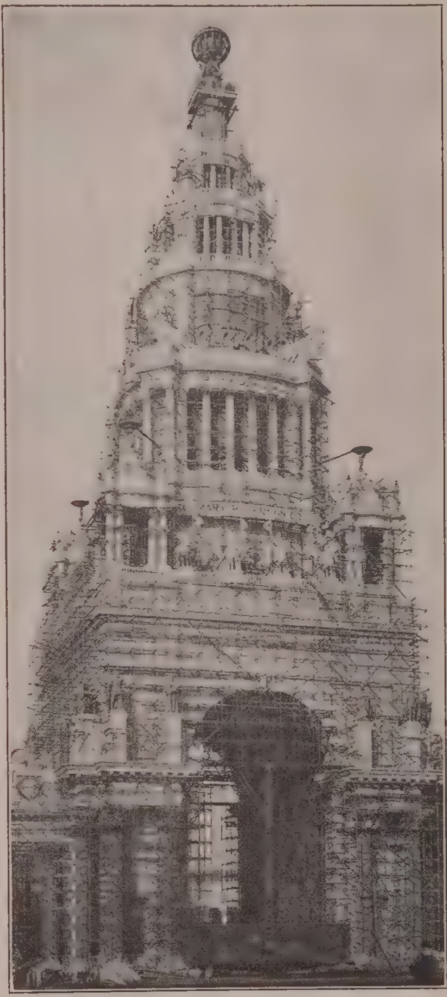
STRESS ANALYSIS

For the complete analysis of stress in each of these types of frame, three cases of loading were investigated, as follows: Dead loads alone; dead loads plus loads from wind parallel to the main frames; dead loads, plus loads from wind perpendicular to the main frames.

In the adaption of these three cases to the analysis of an elastic arch, it is necessary to depart from the usual method of procedure by which the stresses resulting from the dead loads are selectively combined with those resulting from live or wind loading, for maxima and minima. Since the theory of least work assumes the stress in any particular member dependent upon the stress existing simultaneously in all of the other members of the frame, it is evident that the total load at each panel point resulting from whatever cause, dead, live or wind, must be put upon the frame as a unit, and the analysis carried through for that combination of loading.

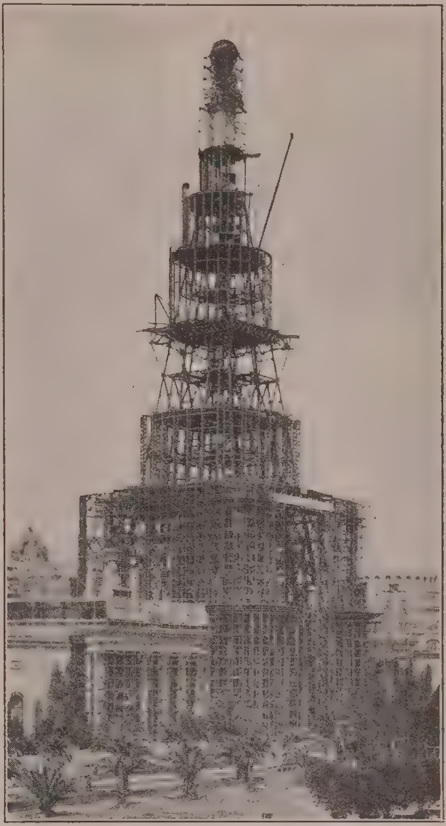

ELEVATION OF STEEL FRAME

Applying the three cases to the frame in question resulted in the following: Vertical dead loads only; vertical dead loads as for the preceding case, plus vertical wind concentrations of either tension or compression and horizontal wind concentrations on the upper chord of the arch at the bases of the columns to the total horizontal wind shear from above; vertical concentrations only, composed of the dead loads plus or minus the uplift or down thrust from the overturning moment of the wind on the frame above. No wind was assumed on the steel frame below El. 152, as the timber structure, which is self supporting, protects the steel frame from the horizontal wind loads. Having the loads upon any frame the distribution of stress was accomplished by the application of the principles of least work to the two-hinged arch. In this analysis Prof. Ketchum's graphical and analytical method, as outlined in his "Steel Mill Buildings," was followed very closely. Pins were assumed at the bottom of the legs and an elastic tie supplied between them.


BEFORE STRIPPING OF SCAFFOLDING

TEMPERATURE STRESSES

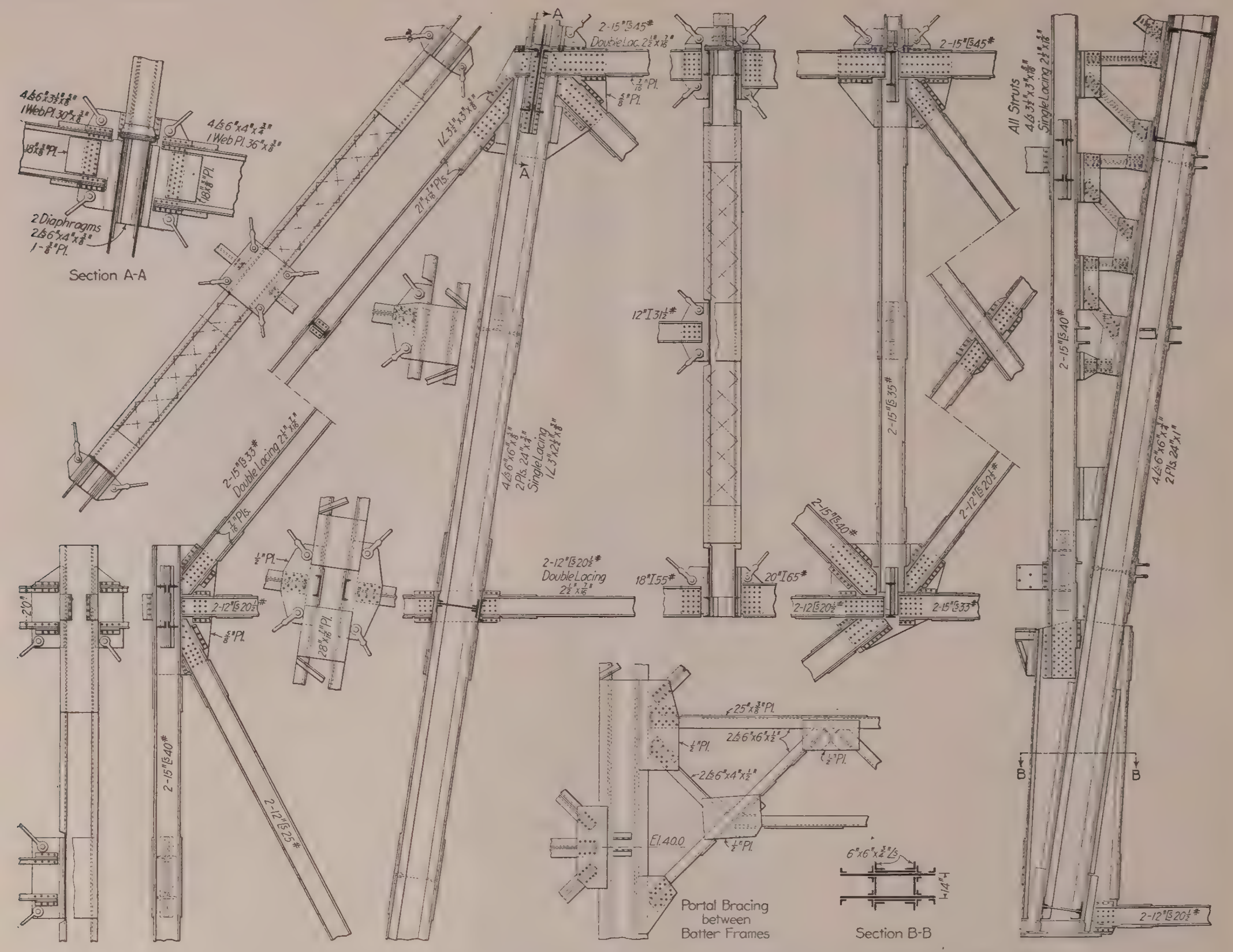
In the matter of temperature stresses, it is evident that the enclosing of the steel frame within the timber and plastered walls and the burying of the tie members under the pavement of the court, materially reduce the temperature range to which the steel arches are subjected. It was, therefore, thought justifiable to neglect temperature stresses.


TIMBER FRAMING COMPLETE

As a further precaution, in the event that for any reason the frames below El. 152 should not act as two-hinged arches, the stresses were investigated, considering that portion of the arch between El. 126 and El. 152 to act as a simple supported truss, resting upon the lower legs of the arch. This assumption, as is to be expected, greatly increased the stresses in the upper and lower chords at the center of the span. While this condition of stress could never obtain in full degree it was thought advisable to limit the intensity of stress in the several members under these assumptions to 30,000 lb. per square inch. To satisfy this requirement it was found necessary to increase slightly the section of two of the chord members. Though there was considerable question as regards just which members would compose the truss, under those assumptions, the investigation gave additional assurance in the strength of the frame to meet all conditions of load upon it, and served to show the very considerable saving of weight of metal effected by designing the lower frames to act as two-hinged arches.

Following the assumptions of the paragraph above, the legs, themselves, were investigated for stiffness in column action, under the reactions of the simply supported truss. A radius of gyration was taken at one-third the height from the ground, while the length was taken as the distance from the knee-brace to the ground, unsupported in a direction parallel to the plane of the frame. These were found ample by the most conservative formulæ.

The transverse frames were found more difficult of analysis, the concurrence of the



DETAILS OF TWO-HINGED ARCHES AND THEIR BRACING AND OF PORTAL BRACING BETWEEN BATTER FRAMES

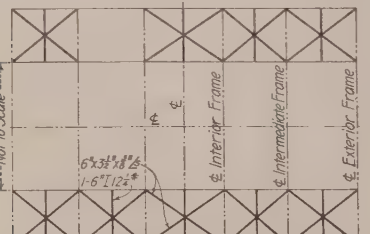
members rendering the panel points indeterminate to the second degree. The following method was evolved: (1) The panel point concentrations at the several levels were first computed and a graphical moment diagram constructed, considering the entire structure as a cantilever fixed at the base. (2) Knowing the bending moment at the various horizontal sections from the moment diagram, it was assumed that the columns would take vertical reactions due to overturning moments in proportion to their distances out from the center or neutral axis of the frame. These vertical tensions and compressions were then computed for the several columns at each horizontal section. (3) The total horizontal shear, at the several levels, was distributed at the bases of the columns equally, inasmuch as these columns do not take this shear in proportion to their stiffness in bending, but receive it as a result of the truss action of the diagonals coming in at their feet. When it is recalled that the various sections are so thoroughly braced horizontally, it is reasonable to assume this uniform distribution of shear at least for the panel next below that in which the wind increment is received into the frame. (4) Having the horizontal and vertical loading, as above, it was possible to take one of the transverse bays out of the frame and analyze it as a unit, stressed under the above mentioned loads. For the upper and lower chords of these transverse bays, which serve in common in two adjacent frames, the algebraic sum of these stresses was taken.

Putting the stresses thus obtained back into the frame as a whole, it was found possible to close the stresses about each of the otherwise indeterminate panel points. As in the case of the analysis of the main frames, mentioned above, auxiliary members were introduced where necessary to simplify the analysis and resolution was made later to obtain the stresses of the actual framing.

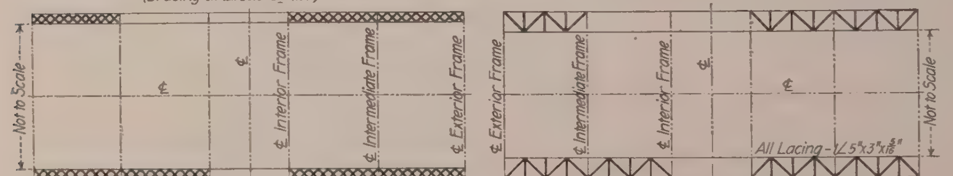
DIAGONAL WIND STRESSES

There still remained, to be investigated, the stresses resulting from a wind striking the tower at an angle of 45 deg. to the axis. It was reasonable to suppose that this might give a condition of maximum stress in the four corner columns, acting as they do, simultaneously, in the main and the transverse frames. For this purpose it was again assumed that the columns took vertical wind stresses in proportion to their distances out from the neutral axis of the tower. Section moduli were, therefore, computed for the different horizontal sections that were to be investigated, about an axis perpendicular to the wind, i.e., at 45 deg. to the axis of the tower. Combining the vertical wind stresses, so computed, with the dead loads in the columns, it was found that the load under 45 deg. wind was in every case from 5 to 25 per cent lower than the maximum load under wind parallel to the frames.

After working out the structural analysis along the above lines Prof. Charles B.



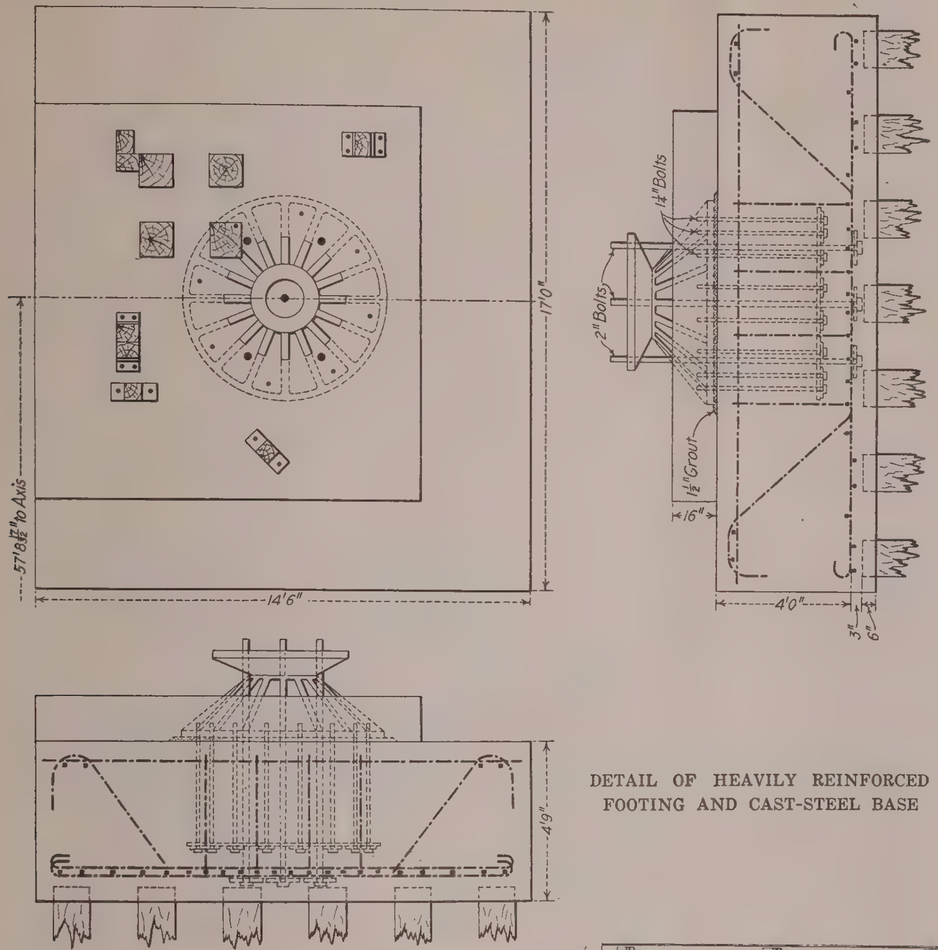
Horizontal Bracing at El. 100.0
(Bracing at El. 80.0 similar)



Horizontal Bracing at El. 20.0

Horizontal Bracing at El. 40.0

HORIZONTAL BRACING OF TOWER LEGS AT VARIOUS ELEVATIONS



DETAIL OF HEAVILY REINFORCED FOOTING AND CAST-STEEL BASE

Wing, of Leland Stanford Jr. University, was retained in a consulting capacity, particularly as to whether the application of the methods of least work to the analysis of so massive a frame was justifiable as well as in the matters of temperature stresses and the stiffening of the upper chords of the two-hinged arches for simple truss action, should they be subjected to those conditions. In these particulars he concurred fully with the methods adopted.

WORKING STRESSES

The working stresses used in the design may be briefly summarized as follows:

(1) For truss and column members axial dead load was taken at 16,000 lb. per square inch for tension and $16{,}000 - 70\,l/r$ for compression. Where axial wind loads were combined with dead loads, an 0.8 factor was introduced into the former before combining with the dead load, in effect working the steel at 20,000 lb. per square inch under the wind load.

(2) Horizontal members of floor systems, under combined direct stress and bending, were so designed that the extreme fiber stress in bending, plus the intensity of axial stress, uniformly distributed over the cross-section, should not exceed 16,000 lb. per square inch.

(3) Wind loads in diagonal tension rods were taken at 80 per cent of the stresses resulting from a 30-lb. wind, and designed at 20,000 lb. per square inch. This was thought justifiable in view of the considerable stiffness of the frame itself, and the improbability that the whole frame would be loaded with a 30-lb. wind pressure at any one time. The partial transverse frames mentioned above, which were neglected in the analysis, further operate to reduce the intensity of the wind stresses in these rods.

(4) To guard against any weakness due to faulty end connections between rods and gusset plates, the pins and clip angles were designed on a 20,000 lb. per square inch basis, thus giving them 20 per cent additional strength over the main section of the rods coming upon them. To insure the snug fitting of the rods against the pins, so that no slack would be present to be taken up before their working, an initial tension stress of 5000 lb. was added to each rod, in addition to its computed load.

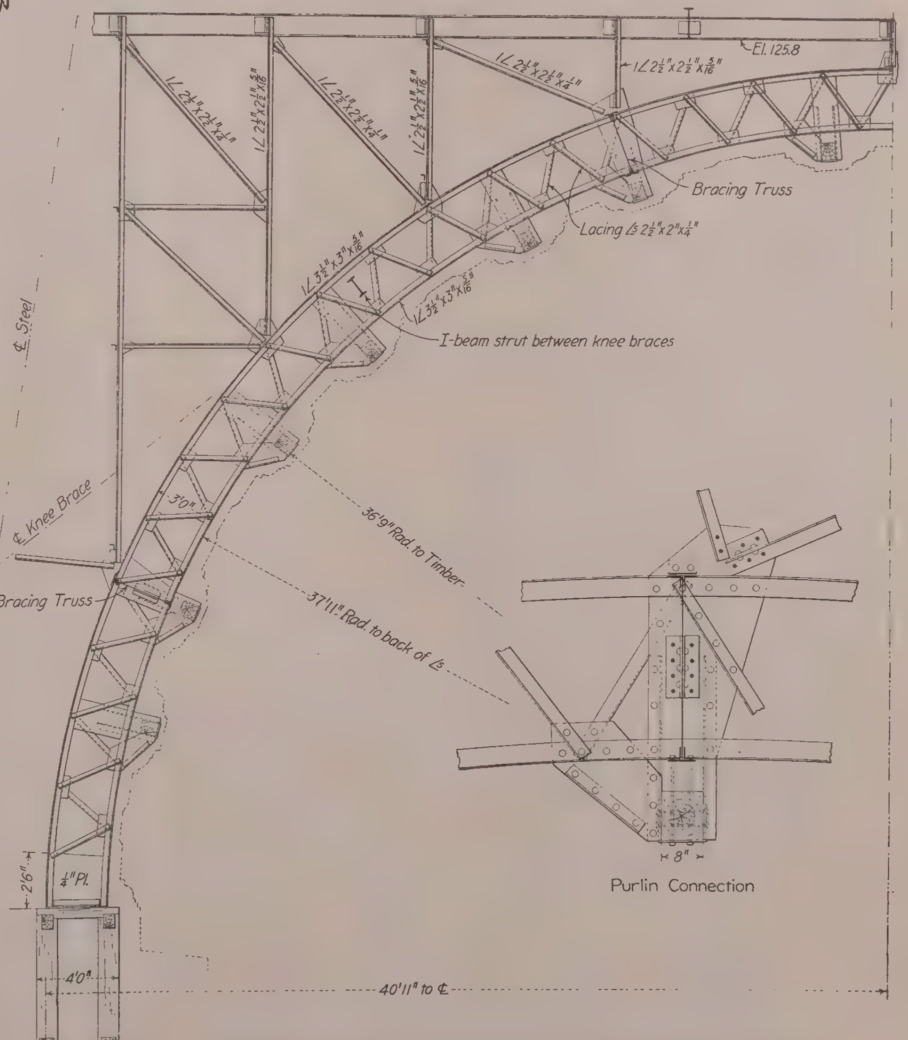
For the structural details, the following unit loads in pounds per square inch were used: Shop rivets in single shear, 11,000; shop rivets in bearing, 22,000; field rivets in single shear, 8800; field rivets in bearing, 17,600; turned bolts in single shear, 8800; turned bolts in bearing, 17,600; ordinary bolts, in single shear, 7000; ordinary bolts, in bearing, 14,000.

Turned bolts were used in vertical splices in columns, ordinary bolts being used in all other positions.

In the timber design the following working values, in pounds per square inch, were used: Tension with grain, 1200; compression, end bearing, 1600; compression, cross grain, 350; bending, extreme fiber, 1500; shearing with grain, 150; modulus of elasticity, dead load, 1,000,000; modulus of elasticity, live load, 1,500,000; columns under $2/d = 15, P = 1200$; columns over $2/d = 15, P = 1600$ $(\frac{1}{2}/60d)$.

FOUNDATIONS

Piles were driven in clusters under the feet of the twelve main columns, the num-



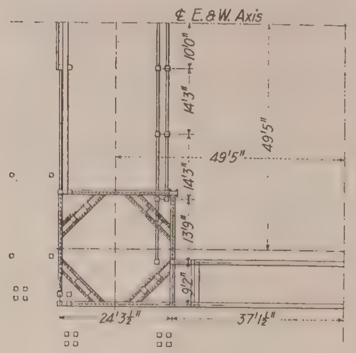
ARCH FRAMING AND METHOD OF CONNECTING TOWER FRAME bers in the groups ranging from 25 to 42. The piles in each footing are capped by a block of concrete, rectangular in plan to suit the arrangement of the piles.

In addition to the main rectangular blocks, considerable concrete was poured subsequently in and about the cast steel bases for the support of timber columns. A well graded 1:6 mixture was used for the piers. Six concrete troughs were placed for the support of the steel tie members between the pins of the main arches. These troughs were for the dual purpose of heat insulation and protection from bending under settlement of the roadway, the ties being placed as close to the surface as practicable. After the steel erection was complete, these troughs were filled with a 1:8 concrete.

With the exception of the large timber columns of the tower proper, all timber framing in the colonnades and the small courts is carried on spread footings, with sand boxes introduced where necessary to offer anchorage against overturning wind moments.

Cast Steel Bases

For the feet of the two-hinged arches it was thought that some provision should be made to guard against indeterminate bending in the legs, such as might result from unequal settlement of the foundations, unsymmetrical wind or temperature loads, or other such cases. A uniform distribution of the load was of course desired between the cast steel base and the concrete of the footing. All of these ends were accomplished by the use of a segmental spherical bearing. Also such a bearing greatly facilitated closing the arches in erection.



These bases are of cast steel, circular in plan, and 6 ft. in diameter. A concave spherical bearing, turned to a radius of 3 ft., was supported, concave upward, upon sixteen radial ribs. Into this socket was placed the convex bearing shoe which bolts to the structural steel of the leg.

The plans were prepared by the division of works of the exposition company, of which H. D. H. Connick is director and A. H. Markwart, assistant director of works. The structural work and substructure were designed by the writer and others under the immediate supervision of H. D. Dewell, chief structural engineer. The architectural design was by Thomas Hastings of New York.

The first design of the structural part of the tower was made by J. D. Galloway, consulting engineer, of San Francisco, the writer acting as his principal assistant. The steel contractors were Dyer Brothers, of San Francisco, while the general contract, including all except the steel frame, was executed by Commary-Peterson Company, Inc., also of San Francisco.

Pumping-Station Duty in Detroit for the year ended June 30, 1914, was 88,906,868 ft. lb. per 100 lb. of coal, with all coal used for heating surrounding buildings charged against the quantity of water pumped. Costs of operating the stations for the year per 1,000,000 gal., according to the report of Theodore A. Leisen, general superintendent of the waterworks, were $1.66 for labor, $1.45 for fuel, 4 cents for oil and waste, 11 cents for supplies and waste and 8 cents for miscellaneous items. Corresponding costs per 1,000,000 gal. raised 100 ft. are $1.35, $1.18, 3 cents, 9 cents and 7 cents. The cost of water per 1,000,000 gal. figured on total maintenance was $6.23. If the interest on bonds is added the cost is raised to $7.61. The cost of pumping alone is $3.34, and for a lift of 1 ft., 2.7 cents.

Pavement Troubles Along Car Tracks Eliminated

Wood Block Laid on 1:4 Cement and Sand Cushion Sprinkled with Water Prove Satisfactory at Newark, N. J.

Last season Broad Street, the main business thoroughfare of Newark, N. J., was paved for a distance of 1.9 mi. with wood blocks treated with 18 lb. of creosote oil having a specific gravity of not less than 1.07 nor more than 1.12 at 38 deg. C. The 1-in. cushion laid on 8 in. of concrete was a mixture of 1:4 cement and sand, lightly sprinkled with water before laying the blocks.

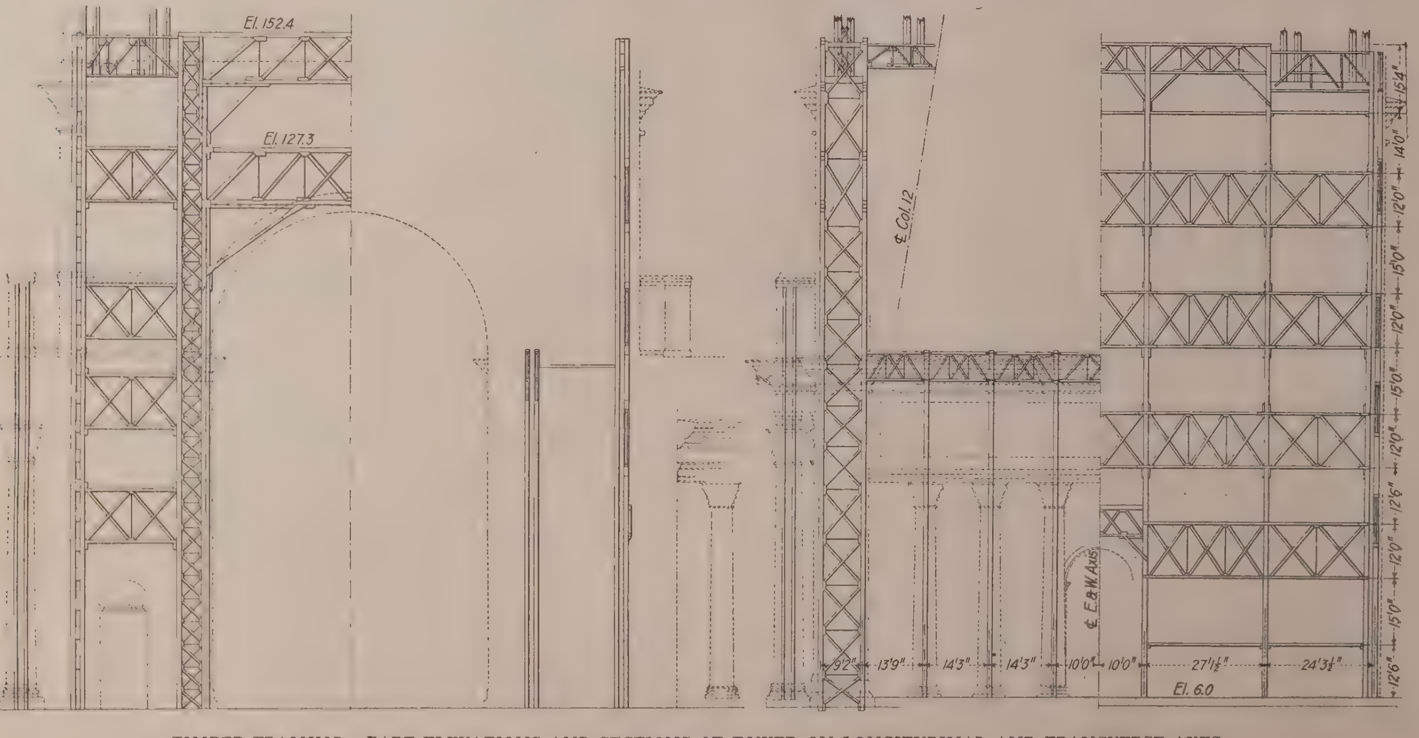
In consequence of this procedure, according to a paper by William A. Howell, read at the recent Chicago convention of the American Road Builders' Association, less than a dozen spots adjacent to the street-car tracks caused trouble from the shifting of the sand. At the uneven rail joints the company was able to prevent further hammering by grinding down the joints and then relaying the blocks in cement for a distance of 1 ft. from the rail.

Remedy for Bleeding

Bleeding occurred when the temperature reached 90 to 97 deg. Fahr. in the air, and 150 deg. on the pavement, but it was remedied by sanding, which formed a crust, removed early in the fall. It did not stick to leather, track or cause particular comment. Two kinds of oil were used, but so far the difference is not discernible.

Expansion joints, 1½ in. wide were provided along the curb only. The blocks were laid loosely and all soaked in water for 10 min. before laying. For this purpose 40 to 50 tubs were provided. This is the novel feature of this pavement.

The street is 92 ft. wide between curbs and 38½ ft. between curb and rails. Plenty of room therefore existed for traffic platforms 6 in. high, 85 ft. long and 6 ft. wide, placed 2 ft. outside of the rails. They do not interfere with vehicular traffic and have elicited, it is said, a great deal of appreciative comment.



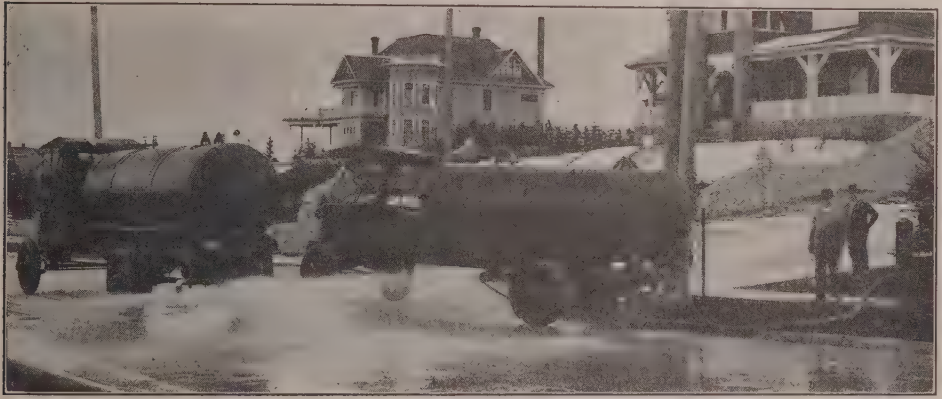
TIMBER FRAMING—PART ELEVATIONS AND SECTIONS OF TOWER ON LONGITUDINAL AND TRANSVERSE AXES

Electric Street Sprinkler Does Work of Three Teams

Motor Vehicles Will Replace All Horse-Drawn Equipment for Municipal Department Work in Calgary, Canada

TWO of the eight electric trucks used for nearly a year by the several municipal departments of Calgary, Canada, have effected a daily saving of $24 in the cost of sprinkling and flushing streets. Cost records for these and the other six machines have indicated such a substantial saving by the use of the electrically propelled vehicles that they will replace all of the horse-drawn equipment as the latter wears out.

The electric trucks were supplied by the General Motors Company and are three 1-ton trucks for the electric light, stores, and street railway departments; two 3-ton trucks for the waterworks and stores departments; one 5-ton truck for the sanitary department, and two 5-ton trucks for the street cleaning department.



IN CALGARY ELECTRIC TRUCKS HAVE REDUCED THE COST OF STREET SPRINKLING

The electric sprinklers and flushers cost $11,440. Each sprinkler does the work of three teams and each flusher the work of two teams.

During the summer months the sprinklers and flushers are operated day and night shifts of 9 hours' sprinkling by day, and 8 hours' flushing by night, at a saving of about $24 per day of 17 hours over horse-drawn machinery. During winter months, the tanks are removed and replaced by boxes which will hold 6 cu. yd. of refuse.

Calgary has 1,300,000 sq. yd. of pavement, covering 54 mi. of paved streets. The full equipment for keeping this clean consists of four horse flushers, four rotary brooms, two squeegees, five horse sprinkling tanks and two 5-ton electric motor trucks. In a test the two trucks used by the street cleaning department averaged 38 mi. each per day of 9 hours' sprinkling, and 17 mi. each per night of 8 hours' flushing. This work cost $1.30 per truck for current during the 17 hours.

TRUCK SPECIFICATIONS

The specifications for the 5-ton electric sprinkler truck follow: Water capacity of tank, 1200 U. S. gal.; total length of tank, 160 in.; inside diameter, 51 in.; air compartment in forward end of tank, 36 in. long—25 per cent of tank volume; pressure in air tank, 65 lb.; total weight of tank, 3600 lb.; tank provided with air and water pressure, gage and pop safety valve in by-pass connecting water space with air chamber. The tank is filled by means of a 2½-in. water intake valve located in the center of the rear drum-head. The water discharge is controlled through lever gate valves operated by hand at the driver's seat. The two flusher nozzles may be worked together or independently. The main outlet connection is a 4½ in. standard pipe; the flushing nozzle connections, 2½ in. pipe.

The interest, sinking fund, depreciation and special battery depreciation is not charged direct to the different departments, a special fund being set aside for this purpose. In the report from the electric vehicle department summarized herewith, vehicle repairs for the month of March, 1914, were $387.36. This included a new set of rear tires for one of the sprinkling trucks, at a cost of $380 the pair.

WATER STERILIZATION IN DETROIT cost $5150.31 for the year ended June 30, 1914. This is equivalent to 12½ cents per 1,000,000 gal. An average of 1 part of available chlorine to 3,000,000 parts of water was used.

OPERATING COSTS AND FIXED CHARGES FOR EIGHT ELECTRIC TRUCKS IN CALGARY, CANADA

									Monthly average per vehicle	
Vehicle No.	1	2	3	4	5	6	7	8	For March	To date
Capacity, tons	1	1	3	3	5	5	5	1	..	..
Supplies	$0.50	$0.50	$0.65	$0.65	$0.75	$0.75	$0.75	$0.50	$0.63	$0.63
Repairs	23.71	36.29	13.37	168.90	370.29	387.36	11.98	....	120.56	28.90
Current	11.68	11.97	16.78	14.63	54.01	19.82	12.34	1.87	17.89	14.45
Garage	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Garage employees	28.75	28.75	37.75	37.75	42.75	42.75	42.75	28.75	36.25	42.01
Drivers' wages	80.00	75.60	99.15	72.45	80.00	80.00	80.00	20.70	73.49	79.24
Total maintenance	107.22	163.11	177.70	304.38	557.80	540.68	157.82	61.82	258.82	175.23
Int. sk'ng fnd., dep.	50.83	50.83	68.33	68.33	84.16	92.91	92.91	50.83	69.88	71.01
Sp. Bat. Dep.	14.58	14.58	23.61	23.61	27.78	27.78	27.78	14.58	21.79	22.21
Total charges, month	172.63	228.52	269.64	396.32	669.74	661.37	278.51	127.23	350.49	268.45
Total charges to date	1,933.03	1,955.85	2,468.76	2,417.52	2,997.29	3,033.54	2,564.58	885.59	2,282.08	268.45
Av. cost per month	214.78	217.32	274.31	268.61	233.03	337.06	284.95	177.12	263.39	268.45
Days in service	26	26	27	24	26	11	26	16	..	..
Miles, month	796	649	525	562	696	180	403	140	494	615
Total miles	7,176	7,061	5,080	5,375	4,581	5,855	5,208	1,475	...	...
Months in service	9	9	9	9	9	9	9	5	...	...

Book Reviews

Parts I and II of the "Proceedings" of the Seventeenth Annual Meeting of the American Society for Testing Materials, held at Atlantic City, June 30 to July 3, 1914, have been received. Part I contains the committee reports and makes a 6 x 9-in. book of 484 pages. Part II, which contains 678 6 x 9-in. pages, is devoted to the technical papers and the discussion thereof. (American Society for Testing Materials, Office of the Secretary, University of Pennsylvania, Philadelphia.)

MECHANICS OF MATERIALS. By Mansfield Merriman. Cloth, 5½ x 8½ in.; 524 pages; 188 illustrations. New York. John Wiley & Sons, Inc. $4 net.

This edition is practically the same as the tenth edition, of 1905. Some changes have been made in the discussion of testing machines, and new matter has been added on influence lines, curved beams, springs and moment of inertia. The matter added is given a very brief treatment. The effect of the direct shear on the deflection of a helical spring is not considered, although this is an important consideration in the case of closely wound springs.

The great popularity of this text is shown by the fact that since the publication of the first edition, in 1885, thirty-nine thousand copies have been printed, and of this number sixteen thousand have been printed in the last seven years. For almost thirty years this has been one of the leading textbooks on this subject, and it bids fair to continue in this position for many years to come.

FOUNDATIONS. By Malverd A. Howe, Professor of Civil Engineering, Rose Polytechnic Institute. Cloth, 6 x 9 in.; 110 pages; 55 illustrations. New York, John Wiley & Sons, Inc. $1.25 net.

(Reviewed by F. H. Constant, Professor of Civil Engineering, Princeton University, Princeton, N. J.)

This book of 110 pages is evidently intended as a short elementary course on foundations for the author's own classroom. Many important topics are briefly and, of course, very inadequately touched upon. Following closely upon the publication of two extensive treatises on the same subject, it covers no new ground.

Chapter 1 is on the explanation and supporting capacity of soils. Chapter 2 treats of wall and column footings of masonry, concrete, steel I-beams and wood, and gives formulæ and numerical examples for the design of such footings. The design of rectangular concrete beams reinforced on the tension side is just touched upon, and is made possible by the use of a diagram. Chapter 3 discusses piles and pile foundations. The various types of concrete piles are briefly described. Steel sheet piling receives bare mention. Chapter 4 gives a brief discussion of the maximum pressures under chimneys and towers. Chapter 5 discusses bridge piers and abutments, various types of cofferdams, open caissons and cylinder piers, and the manner of unwatering cofferdams, and illustrates several kinds of pumps.

Chapter 6, entitled "Methods Employed for Difficult Foundations," devotes fourteen pages to the pneumatic caisson for bridges and buildings, the open dredging and the freezing processes, and will hardly prepare the reader to handle very difficult problems of this nature.

The book closes with an appendix containing a collection of the formulæ used in the text. A valuable feature is the list of references at the close of each chapter. The text and numerous illustrations are clear and pleasing.

HISTORY OF RENSSELAER POLYTECHNIC INSTITUTE, 1824-1914. By Palmer C. Ricketts, E.D., LL.D., President and Director of Rensselaer Polytechnic Institute. Cloth, 6 x 8½ in.; 269 pages; illustrated. New York, John Wiley & Sons, Inc. $2.50 net.

Rensselaer Polytechnic Institute is not among the large or the wealthy engineering colleges of the world. Even now its total assets amount to less than $3,000,000, although in the last decade of its 90 years of life these assets have been multiplied by five. Yet in point of the quality of instruction given, and the impression made on engineering progress by its graduates and professors, it has long been counted in the foremost ranks of the world's engineering colleges.

President Ricketts' book shows well what confidence in and devotion to an ideal can do toward building up the value of such an undertaking. Stephen Van Rensselaer, descendant of early Dutch landholders, graduate of Yale, member of Congress and veteran of the war of 1812, conceived the idea of teaching the people of his district and country by lectures and investigations conducted at his own expense, and by the founding in 1824 of the school which bears his name, the application of science to domestic and industrial problems. Such a thing had scarcely been tried or even thought of in any English-speaking country; all science was in its infancy, and engineering as a profession did not exist.

Amos Eaton was the man who made these investigations, delivered the lectures and carried on the work of instruction in the school. To his ability as an investigator and teacher, marked by the character of pupils he attracted, the start of the school is to be ascribed. Both of these men live again in the first chapters of President Ricketts' book.

The growth of the school is traced through its incorporation in 1826, the changes in its administration and methods of instruction of the early '50's and its phenomenal physical development following the fire of 1904 to its present-day methods, aims and equipment. Woven into its history is an interesting story of the development of student life.

The book is of great historical value to educators, and should be a matter of interest and pride to all the alumni of the Institute, and, indeed, to all American college men.

THE PRESERVATION OF STRUCTURAL TIMBER. By Howard F. Weiss, Director, Forest Products Laboratory, U. S. Forest Service. Cloth, 6 x 9 in.; 312 pages; 31 illustrations. New York, McGraw-Hill Book Co., Inc., $3 net.

(Reviewed by C. M. Taylor, Superintendent of Treating Plants, Central Railroad of New Jersey and Philadelphia & Reading Railway, Port Reading, N. J.)

In this book the author has compiled the results of the major portions of the timber-preserving investigations as carried on by the laboratory at Madison, Wis. The book deals with the industry in general and puts the information in such shape that the engineer and architect will be enabled to form their own opinions as to the desirability of using treated timber and the process that should be used. It goes into some considerable detail as to the mechanical equipment of plants, although this portion of the book has not been covered as well as experienced operators would desire—especially the point covered in advising the use of retorts with only one door.

The article on the inspections of treatments could have been more carefully covered, because more chance for errors of judgment arises in that connection than with any other part of the industry. The cost of plants is based on a formula used some years ago and ought to be revised, because it does not include the full equipment of a modern timber-preserving plant.

The chapter on prolonging the life of crossties has much to commend it, and maintenance engineers can well afford to adopt some of the suggestions proposed. The cost figures in connection with ties are more nearly in accord with commercial prices than is usually the case with Governmental publications.

The author suggests a tilting cylinder for impregnating the butts of poles and piling. This seems the natural thing to do and it is to be expected that some such practice will result, with the increasing cost of preservatives and the decreased cost of such a means of treatment. As shown by the author, there are many possibilities for its application.

The chapter on paving blocks has some very useful suggestions in connection with treatment to prevent "bleeding" at no added cost.

Discussions of the questions of sap stain and fire protection, together with a very conclusive article on the question of electrolysis in connection with use of block signals where Burnettized ties are used, conclude the already instructive volume. A complete list of wood-preserving plants, together with the names of firms producing creosote and zinc chloride and the names of companies equipped to build timber-treating plants, forms a very useful appendix. A list of 381 United States patents on timber preservation, giving the names and addresses of the inventors, the purposes and numbers of the patents and the dates issued, afford a very good means of showing how thoroughly inventors have attempted to cover the field.

RESISTANCE OF MATERIALS. By S. E. Slocum, B. E., Ph.D., Professor of Applied Mathematics in the University of Cincinnati. Cloth, 6 x 9 in.; 210 pages; 152 illustrations. Boston, Ginn & Company, $2.

(Reviewed by Melvin L. Enger, Assistant Professor of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill.)

According to the preface, "The chief feature which distinguishes this volume from other American textbooks on the same subject is that the principle of moments is used consistently throughout in place of the usual calculus processes. By basing the work on this principle it has been found practicable to give a simple and obvious treatment of many topics for which the calculus is usually thought indispensable, such as the calculation of moments of inertia, the deflection of beams, the buckling of columns and the strength of thick cylinders. . . . The mechanics of materials is of such fundamental importance in all branches of technology that it is important to begin its study as early in the course as possible. Heretofore it has been necessary to defer it—awaiting the completion of the calculus—until the junior year, when the curriculum is already crowded with technical subjects requiring its application. This text makes it possible for the course to parallel or even to precede the calculus. In addition, it makes the subject available for trade or architectural schools where no calculus is taught."

The book is divided into fourteen sections. At the beginning there are 23 pages of mathematical and physical constants, which include the properties of I-beams, angles and the like, logarithms, functions of angles, bending-moment and shear diagrams, weights and the properties of materials of construction. At the end of each section is a list of problems, forming in all one of the best collections of problems in this subject. Answers to the problems are given at the end of the book.

The text is marred by the loose use of terms, and by incomplete definitions. As an illustration, "It is found by experiment that as long as the stress does not pass the elastic limit the deformation disappears when the external forces are removed. If the unit stress (or, more properly, the unit deformation) exceeds the elastic limit, however, then the deformation does not entirely disappear upon the removal of the load, but the body retains a permanent set." Here we have elastic limit defined as stress, unit stress and unit deformation. In another place elastic limit is defined as a point on the "strain diagram." The definitions of bending moment and of vertical shear seem to neglect the fact that these quantities have signs as well as magnitude. Throughout the book the term stress is often used when unit stress is meant.

The proof of the general formula for the deflection of beams, $d =$ (static moment of moment diagram)$/EI$, is not sufficiently detailed for the average student. The equation permits the determination of the deflection of cantilever and simple beams under various loadings without the use of calculus. The author then presents an ingenious method in which the equation for the deflection of a cantilever beam under various loadings is used, by means of which the theorem of three moments for a continuous beam is easily derived. Even the general case of a continuous beam carrying concentrated loads on unequal spans, and with supports at different levels, presents no difficulty.

In the section on columns and struts an approximate derivation is given of Euler's formula. Rankine's formula, J. B. Johnson's parabolic formula and T. H. Johnson's straight-line formula are given and discussed. Eccentric loading is treated by means of the straight-line formula. Then follow sections on torsion, spheres and cylinders under uniform pressure, flat plates, riveted joints and connections, reinforced concrete and simple structures. In some of these sections formulæ are given without proof. Seven of the eighteen pages on reinforced concrete are devoted to the mushroom system. Nothing is given on horizontal shear or on combined stresses.

All things considered, the book is a valuable addition to the literature on the mechanics of materials. As a reference book it will be found more useful than some of the more pretentious texts. The typographic work is excellent.

FREE COAL FOR ALASKA has been made possible by an act of the Secretary of the Interior, who has authorized opening in 10-acre tracts to the people of the Territory all coal lands except the Bering River and Matanuska fields. The grants are for two years, and it is only necessary to stake the ground and apply to the local receiver for the use of it.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and
construction engineers are indexed in the Table of Contents

Remodeled High-Speed Mower Cuts Large Weeds and Brush

By J. G. BENNETT
New Orleans Lake Shore Land Company

OFTEN contractors are put to considerable expense in clearing the weeds, brush, and undergrowth which covers the site of their operations. The ordinary mower will not cut large weeds and brush, but can be remodeled at a very slight expense so that it will do the work much cheaper and closer than it can be done by hand. A gasoline engine is mounted on the frame of the mower and used to speed up the sickle bar. This makes the rate of motion of the mower and the speed of the sickle bar independent. Thus the sickle, running at a high speed, may be gradually brought against a large weed or bush that would choke the common horse-drawn mower. The mower shown in the picture is drawn by a gasoline tractor made from an old "one-lunger" automobile. It cuts bushes 1 in. thick and will clear from 5 to 10 acres of tough weeds in a day.

SICKLE BAR ON MOWER SPEEDED UP BY GASOLINE MOTOR

Contractor Places 84,450 Yards of Masonry in One Month

IN the article entitled "Electrically Operated Contractor's Plant for Building Kensico Dam," which appeared in the Engineering Record of Jan. 2, 1915, and also in the editorial comment thereon, reference is made to the record volume of masonry placed in a single month as being 65,290 cu. yd. This was the record for May, 1914. Wilson Fitch Smith, division engineer of the New York Board of Water Supply calls attention to the fact that this record was exceeded as follows: June, 1914, 76,970 cu. yd.; July, 69,550 cu. yd.; August, 84,450 cu. yd.

Of the total amount placed in August, 1,310 cu. yd. were placed by a second shift. Deducting this, the quantities for the month of August are as follows:

Number working days (8 hours)....	26½
Total masonry placed in dam........	83,140 cu. yd.
Average amount of masonry per day.	3,137 cu. yd.
Best day's work....................	3,572 cu. yd.

This stands as the maximum performance of H. S. Kerbaugh, Inc., the contractor, for a month, but a most interesting feature of this work from the standpoint of plant efficiency, according to Mr. Smith, is the high daily average maintained for the whole season. From March 17 to Dec. 2, 1914, a total of 489,750 cu. yd. of masonry was placed in 221½ working days, or an average of 2211 cubic yards per day for the entire season.

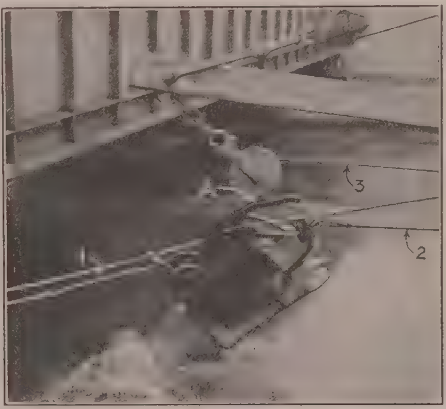
No Obstacles Bothered This Drag-Line Excavator

WHILE quietly "walking" from the Ellsberry, Mo., depot to a drainage ditch 2½ mi. away, recently, a drag-line excavator encountered a ditch 60 ft. wide and 9 ft. deep, obstructing its path, and as there were no bridges of sufficient strength over which the excavator could continue its journey in safety, the machine borrowed earth by means of its 60-ft. boom and 3-yd. bucket, filled in the creek, walked across and then turned around and removed the material which it used to cross the stream and continued on its way. Only one day was required to fill in the stream at the crossing point, walk across, and remove every vestige of its temporary crossing. The excavator, a Monighan, is owned by the W. E. Callahan Construction Company, of Omaha and Kansas City.

Dredge Dipper Rigged as Drag

By O. S. PROCTOR
Superintendent, Canal Construction Company, Inc., Hyde Park, Mass.

THE accompanying view shows clearly a good use to which a ¾-yd. dredge dipper was put by the Canal Construction Company on the Neponset River improvement work in Massachusetts. The dipper was used as a drag to dredge under bridges when the derrick boat could not reach. The derrick boat was the usual three-line A-frame rig, handling an orange-peel bucket. To operate the dipper the boom was set at the desired height, the boom fall clamped off and removed from the drum. The line marked 1 on the cut was put on the drum in place of the boom fall. The closing line of the orange-peel was taken out of the block on the end of the boom and attached to the dipper bail; it is marked 2. The trip line of the orange-peel, marked 3, is fastened to the front end of the top leaf of the dipper. The bight of line 1 passes through a block on the left side of the bridge, not shown in the view. This block is anchored by a shackle, through which is run a wire line spanning the channel to be dredged. Hand lines to each bank are used to slide this block along this wire line, so that the dipper can be made to take successive cuts until the whole channel has been dredged.



DREDGE DIPPER RIGGED AS DRAG

The trigger, marked *A*, made of two flat

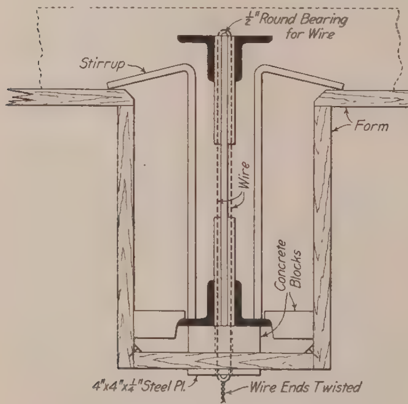
THIS EXCAVATOR PLACED FILL IN STREAM BED, WALKED ACROSS EMBANKMENT, AND RESTORED CHANNEL TO ORIGINAL CONDITION IN ONE DAY steel bars, is hinged at the back of the dipper and tiled just behind the hinge to the latch. With the dipper in the position shown, a slight additional pull on line 3 will force this trigger against the block and draw the latch, tripping the bucket. All lines are then slacked till the dipper strikes bottom. The outhaul, 1, is then tightened. As can be readily seen from the point where the end of this line is attached, the dipper sits on its door while being dragged to place for a new cut. While in this position a strong spring on the back of the door shoves the latch home. When dragging the dipper back under the point of the boom with line 2, a slight tension on line 1 keeps it from turning around or from tipping forward over the teeth. The only other alteration made to the dipper is the device for holding the bail rigid. This can be seen in the cut, and consists of two bent straps riveted to the bail and to the top of the dipper.

Suspended Beam Forms—Their Advantages and Disadvantages

By **SIDNEY DIAMANT**
Consulting Engineer, New York

FROM time to time are proposed concrete beams so designed that in their construction the necessity of wood shoring under the forms is eliminated. To facilitate this the reinforcing steel is made to carry the dead load of the floor system, considering the former as acting alone and independent of its combined effect when bonded with the set concrete. Generally the regular bar reinforcement is replaced by a latticed steel truss of a depth permitting the covering of its top and bottom flanges with 1½-in. thick concrete.

There is an economic depth for the truss to resist the stresses developed only by the dead load or weight of the construction. However, this depth may be somewhat reduced because of the greater value of the truss in the completed reinforced beam to resist stresses developed by the total load. As this type of construction seems advantageous in many cases, especially when long spans have to be built, the writer has made a careful analysis of the design of such beams, their advantages and disadvantages. The following case was assumed: A 10 x 19-in. reinforced-concrete beam, previously calculated, is modified to meet the requirements for the use of suspended forms. The forms are held by wires passing through the space between adjacent chord angles and provided top and bottom with half-round bearing bars, as shown in the accompanying drawing. Previously cast concrete blocks insure the proper relation between truss and form. To release these forms it is necessary only to drive out the lower bearing bar and clip the suspension wires.



FORM SUSPENDED FROM BEAM

The weight of the 16-in. steel truss, calculated for dead load only and not including impact due to depositing concrete, is 17 per cent higher than the steel bar reinforcement of the original beam, figured as a constrained member. Because of the distribution of the truss metal, the center of gravity of the steel is raised considerably, thus decreasing the effective depth of the beam by 40 per cent. Consequently, when the steel in this truss is applied to resist the total moment in the reinforced-concrete beam, it is found to be 35 per cent too small. The ratio of beam depth to slab thickness develops a width of T-flange of over twice that permissible by New York building code regulations. The maximum deflection of the truss under its full load of wet concrete is ⅜ in. This is scarcely noticeable over the 26-ft. span of the beam, but when impact is considered, this deflection will undoubtedly increase to about 1 in.

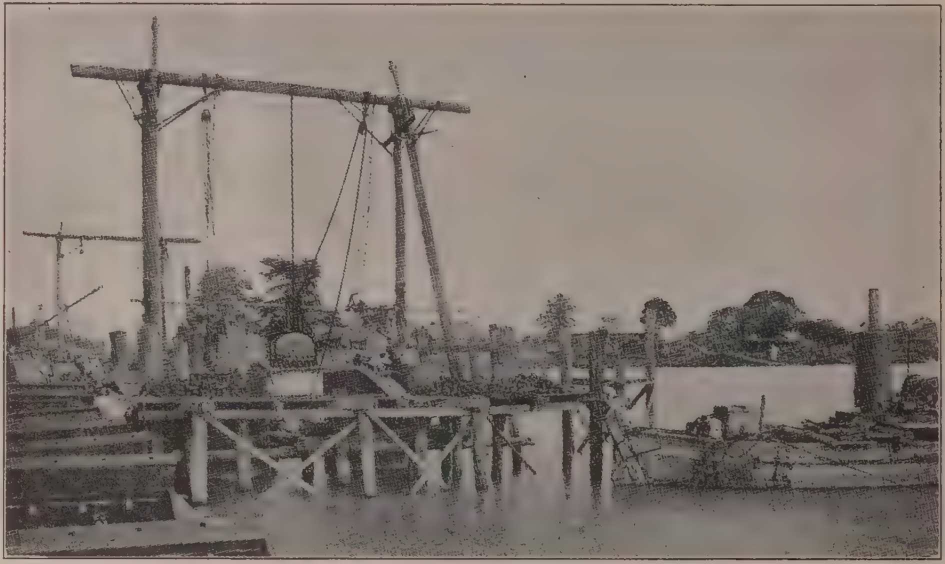
Considering this type of construction the following advantages may be claimed: (1) Available clear space below the forms, permitting the finishing of the floor below and providing room for the building of new forms. (2) Cost of timber posts eliminated. (3) No delay in waiting for the concrete to set before removal of posts, which are to be used again in the upper construction.

The following disadvantages exist: (1) More steel is required. (2) Excess of steel not again available for use in the upper construction as in the case of wooden shoring. (3) Damage to forms and leaking will result from excessive and varying truss deflection during deposition of concrete. (4) Varying deflection during normal conditions of erection will prevent constant contact between steel and concrete, thus preventing proper setting of the concrete and bonding of the component parts.

LIME FOR WATER SOFTENING is being used in New Orleans, St. Louis, Cincinnati, Columbus, Oberlin, Ohio, McKeesport, Pa., Fargo, N. D., and many smaller cities. Saginaw, Mich., and Cleveland will adopt this form of treatment.

One-Drum Hoist Operates Grab-Bucket without Derrick

ENGINEERS in British East India devised the gantry illustrated herewith. A one-drum hoist on a barge, without a derrick, does the work usually requiring in America the use of a three-line derrick boat. Double-cylinder piers were sunk at this bridge, which was constructed over the Sittang River in lower Burma. Lest American contractors object that British methods are slow, it is to be noted that the first train passed over this bridge in August, 1907, twenty-two months after ground had been broken. In that time twenty of these cylinders, 10 ft. in diameter, had been sunk to an average of over 55 ft. penetration each, beside the steel erection and the construction of abutments.



BRIDGE PIER EXCAVATION WITH ONE-DRUM HOIST AND GANTRY

As may be seen the gantry is so built that the trip line may be hung between or outside the cylinders. This work was described at length on Oct. 5, 1914, before the Society of Engineers (British) by A. Stewart Buckle, who was both the engineer and the actual builder of the bridge.

Concrete Mixer Serves as a Hoisting Engine for Excavated Earth

By **SIDNEY K. EASTWOOD**
Owego, N. Y.

ON a small construction job the excavation for an underground concrete coal hopper was materially helped by using the concrete mixer on the work as a hoisting engine for raising the buckets of earth from the pit. The line from the bucket was run up to a block fastened over the excavation and then down to the ground where it passed around a snatch-block and thence to the drum of the concrete mixer. The rope was fastened to this drum. To operate as a hoist the mixer was started and the rope allowed to wind up on the drum of the mixer.

The weight of the bucket was found to be sufficient to unwind the rope and let the bucket fall when the bucket was going down empty. To lower a loaded bucket a brake for the outfit was made by putting a plank between the drum and the frame of the mixer and using it as a lever to retard the rotation of the drum.

Railroads Need Protection as Well as Regulation

E. H. Lee Thinks They Are as Well and Honestly Managed as Other Industries, and Must Prosper if the Country Is to Prosper

THAT railroad prosperity is essential to general prosperity, that dishonest management of railroads is no more common than dishonest management of other industries, and that the public has no right to demand greater efficiency of the railroads than of its own Government, were contentions made by E. H. Lee, vice-president and chief engineer of the Chicago & Western Indiana Railroad, and president of the Western Society of Engineers, at the annual dinner Jan. 13 of the society. Mr. Lee admitted the justice of railroad regulation, but deplored the absence of adequate protection to the railroads. He did not doubt the honesty or sincerity of the Interstate Commerce Commission, but observed that most of its members lacked practical experience in railroad administration, that its duties were entirely beyond its capacity, and that in occupying its time with detail it had in great part failed in its larger problems. He closed with an appeal to engineers to demonstrate that the obligation to protect equals the right to regulate. Extracts from his address follow:

"The principle of the regulation of railroads by the Government is accepted by all as just and right. Therefore, obedience is to be expected. But equity requires that obedience by the railroads shall be accompanied by adequate protection.

THE ALLEGED SINS OF THE RAILROADS

"The railroads in the past have been charged with many errors of omission and commission. These charges fall into three general classifications—that the railroads are over-capitalized, that railroad men are dishonest, and that railroad administration is inefficient. Thoughtful men observe that all new enterprises in the commercial and business world are started on credit, that they involve large elements of risk and that the rewards of any enterprise should be in proportion to the risk. Railroad companies were formerly considered private enterprises, and their status as such has only recently been changed by the decisions of the courts. Therefore, until recent years, in common with all business, their owners have expected profits in proportion to the risks assumed. Even so, the fact remains that most of the capital subscribed by the men who originally financed the railroads has been entirely lost to them. Further, that railroad capitalization today is represented by actual value, is accepted as a fact by very many of the best informed men of the country.

"Some railroad men have been dishonest, but thoughtful men observe that rascality is not peculiar to the railroads, and that rogues are found in all the various walks of life. The iteration and reiteration of charges of over-capitalization, dishonesty and inefficiency is diminishing, and the chief purveyors of these charges at present are men from that noble band of patriots who are public spirited 'for revenue only.'

GOVERNMENT INEFFICIENCY

"Our country in its government, our business in its modes and methods of procedure, even our system of education, are characterized by inefficiency. Through inefficiency in agriculture, a foundation of National well being, our farms, a few short years ago virgin soil the most fertile on the globe, now produce an average yield of less than 15 bu. of wheat per acre, while elsewhere tillage areas cultivated for hundreds of years treble our average production.

INTERSTATE COMMERCE COMMISSION

"No thoughtful man can question the honesty or sincerity of our Interstate Commerce Commission, nor the ability and efficiency of certain of its members. He observes, however, that most of its members lack practical experience in the actual problems of railroad administration. He notes that the commission is overwhelmed with a prodigious burden of detail—most of it self-imposed, the remainder imposed by Congress—the sum total of which is entirely beyond the capacity of any such body, as a mere question of physical endurance. He also notes that the commission has in great part failed to generalize its great and pressing problems, largely occupying its time with fussy detail. He remembers that the efficiency of the commission has been called in question in an official way by at least one of its own members. Can the thoughtful man be criticised, therefore, if he detects the irony of a situation in which the commission attempts to assume the role of instructor in efficiency? The thought to be emphasized is not that the railroads are perfect, or even approximately so, but that relatively the efficiency of our railroad administration is probably far greater than the average efficiency of either Government or of most other business activities.

HOPEFUL SIGNS

"One of the most hopeful signs of the time is the fact that judging from current indications not only the Interstate Commerce Commission but also the business man and the man in the street are beginning to realize that the prosperity of the railroads, while of importance to their security holders and to the men who work upon them, is of far larger importance to the general well-being of the country. They are beginning to realize that the railroads starved will be in the case of the old horse which was taught to eat shavings, but which died just as his education was completed, thereby effectually removing his master's only agent of transportation. They are coming to see that it is neither fair nor reasonable to seek to enforce upon the railroads standards of honesty and efficiency vastly higher and more rigid than those applied to either business of other kinds, or to Government itself.

WHAT ENGINEERS CAN DO

"The engineering profession is intrinsically a profession of efficiency, and in so far as any of its members fail of true efficiency, in that degree do they fail as engineers. With the abounding opportunities lying on every hand for our work as thus defined, how can we as engineers be other than sanguine as to the future? And shall we not also bear our part in helping to create conditions which shall make for the return of general prosperity by calling attention to the fact that the prosperity of the railroad, equally with the prosperity of the farm, spells general prosperity, and by demonstrating to our friends and neighbors as opportunity may offer the truth of the equation that the obligation to protect equals the right to regulate?"

Rules for Special Technical Committees

Adopted by Board of Direction of American Society of Civil Engineers—Appointment, Government and Procedure

RULES for the appointment, government and procedure of special committees have been adopted by the board of direction of the American Society of Civil Engineers. Slightly condensed, they are as follows:

Authorization.—The authorization of special committees is prescribed by the constitution of the society. All special committees are subject to these regulations. The object of a special committee is to investigate and report upon the engineering subjects defined in its title or in an explanatory tatement by the board.

Personnel.—Appointments on committees are made by the board of direction from amongst members of the society and will continue from year to year, except when changes are announced by the board. Before members are appointed the board shall have their assurance that the work of the committee will have their interest and co-operation. A member who does not take an active interest in its work and does not regularly attend its meetings during the year, nor render adequate service by correspondence, may be relieved, and the vacancy filled by the board. A member may withdraw upon request in writing to the secretary.

After the board of direction has appointed the chairman of a special committee, the board will consult with the chairman as to the personnel of the committee. Additional appointments on existing committees shall be made only on the recommendation or with the approval of such committees.

Funds.—The chairman of each special committee, as soon after the appointment of the committee as possible, shall prepare a budget of itemized expenses covering the requirements of the committee for the remainder of that year, and thereafter he shall submit a budget not more than 10 days after the annual meeting of the society. These budgets shall be scrutinized and such appropriations approved as may, in the judgment of the board of direction, be considered expedient. All bills submitted by a special committee shall be approved by its chairman and secretary.

Expenses.—Expenses for items other than stationery and postage shall not be assumed by the society, unless such expenditures were incurred in pursuance of previous authorization of the board or referred to in the annual budget. Extraordinary expenses, such as purchase of instruments, salaries of special employees and traveling expenses, must be specifically authorized and approved by the chairman of the committee. The chairman of each special committee shall return its tangible property and records to the society on the completion of its work.

Officers.—The officers of special committees shall be a chairman, appointed by the board of direction, and a secretary, elected by the committee, who shall assume their duties immediately after appointment.

Duties of Officers.—The chairman shall preside at all meetings of the committee, appoint all subcommittees unless otherwise directed, and be ex-officio a member of all subcommittees.

The secretary shall be expected to attend all meetings of the committee, keep a roll call of the members in attendance and record the minutes in a book kept for that purpose.

(a) He shall conduct the correspondence, receive all communications addressed to the committee and furnish each member a complete copy of all communications.

(b) He shall read the minutes at all meetings, and shall issue notices for all meetings and promptly inform subcommittees of their appointments and duties.

(c) He shall keep a memorandum of all expenses of the committee. He shall prepare an abstract of the minutes of all meetings and forward same to the board of direction for publication in the monthly "Proceedings," and shall perform such other duties as may be required of him.

Meetings.—The committee shall hold a meeting as soon as practicable after its appointment ,at which time subcommittees on organization and scope of the work contemplated shall be appointed. At least two regular meetings of the committee shall be held each year, the time and place to be fixed by the chairman. Special meetings may be called at the option of the chairman or at the request of the majority of the committee, due notice of such meetings to be given to the secretary of the society and to the members of the committee.

Reports.—No final action on committee reports may be taken except at a meeting called for that purpose. Final reports shall receive the approval of a majority of those voting. Dissenting members may present minority reports individually or jointly. Those refraining from voting shall be named in the report. The reports of special committees shall be filed with the secretary of the society at least sixty days before the annual meeting.

Amendments.—Changes in the above rules may be adopted by any committee only upon the approval of the board of direction.

American Society Holds Sixty-second Annual Meeting

G. A. Harwood Defeats Frederic Molitor in Contest for Director—Financial Report Shows Net Reserve Fund of $30,000

HARDLY a ripple occurred to disturb the orderly and conservative procedure at the business session of the sixty-second annual meeting of the American Society of Civil Engineers, held Jan. 20 at the society house in New York City. Unlike last year, there were no constitutional problems to be solved, and the meeting contented itself with a slight improvement in the wording of the only amendment brought up before voting to have it submitted to a letter ballot. The canvass of votes for directors of the first district showed a sweeping victory for the conservative element in the election of G. A. Harwood over Frederic Molitor. All but one of the ten special committees submitted reports of some sort, ranging from formal printed reports to brief informal statements of the work of the year. All of the committees were continued for another year. The board of direction reported a reduction in the society's mortgage debt and an increase in the reserve fund, leaving an excess of the latter of $30,000. An hour after the adjournment of the meeting at 12.30 p.m. 743 registration cards had been given out.

The annual report of the board of direction for 1914 showed a gain in membership of 406, the total for Dec. 31, 1914, being 7678, as compared with 7272 at the close of 1913. The library now contains 24,632 bound volumes, 46,255 unbound volumes, 7688 specifications and 4889 maps, photographs and drawings—a total of 83,464 and a gain of 3608.

Twenty-seven meetings, at which the attendance was about 5450, were held during the year. All of them were held at the society house. At these meetings twenty-nine formal papers, nine of which were illustrated with lantern slides, were presented, in addition to five published but not discussed in any meeting. The number of members and others who took part in the preparation or discussion of these papers was 275.

Financial Condition

During the year $20,000 was paid on the mortgage of the society, reducing the debt to $60,000. Ten additional New York City bonds (par value $10,000) were purchased, so that the society now has a reserve fund of $90,000, par value, on which the interest is $1350 more than that paid on the mortgage. The board points out that this reserve fund should be steadily increased to offset the depreciation on the society house.

The amendment mentioned had to do with changes in the nominating committee and the districting therefor. Gardner S. Williams introduced an amendment to the amendment to include all living past-presidents on the committee, instead of only the last five. His motion was defeated, and it was voted to submit to letter ballot the original amendment with the slight improvement in English already mentioned, Secretary Hunt having testified that it had been drawn up carefully by a committee appointed for the purpose.

A set of rules adopted by the board of direction for the appointment, government and procedure of special committees was read by Secretary Hunt. These rules appear under a separate head on the previous page.

Progress of Special Committees

The three special committees on materials for road construction, steel columns and struts, and compensation of engineers submitted the progress reports already printed. These reports were all accepted with little or no comment. Progress reports not yet printed from the committees investigating the bearing power of soils and stresses in railroad track were similarly received. R. A. Cummings, chairman of the former committee, merely discussed certain sections of the comprehensive report of his committee. The report of the committee on stresses in railroad track, read by Prof. A. N. Talbot, was a concise account of the work to date of that committee in co-operation with the similar committee of the American Railway Engineering Association, touching upon the complexity of the problem, the development of instruments for measuring the stresses, and the beginning of actual tests on the Illinois Central Railroad at Champaign, Ill. These tests have already proved the practicability of the apparatus used.

F. H. Newell, chairman of the committee on a National water law, and Col. C. M. Townsend, chairman of that on floods and flood prevention, reported the same difficulty in getting concerted action from their committees on account of the wide geographical distribution of the members. Mr. Newell mentioned an equal mental separation of the members which had thus far precluded agreement on fundamental principles. The flood committee has had three meetings, and a subcommittee has already prepared a rough draft of a report.

The valuation committee, whose work has been somewhat disrupted by the death of two of its members and the resignation of a third, stated through its chairman, F. P. Stearns, that two three-day meetings have been held recently, but that there was nothing at present to be reported. The committee on engineering education reported that the Carnegie Foundation had taken up the work assigned to the committee and that the committee's function would therefore henceforth be to assist the Foundation.

A resolution introduced by Col. John A. Ockerson was adopted to the effect that the society should be suitably represented at the opening of the Panama Canal.

Prof. Charles D. Marx spoke of the history of the International Engineering Congress, and made an appeal for better support of it by the members of the society. Engineers of other nations have thus far responded much more liberally than those of the United States, considering relative populations and distances from San Francisco.

Prizes

In the announcement of prize awards for papers presented during the year the committee stated that there were other papers considered almost equally valuable, and specially mentioned that of W. E. Lilly, who could not be awarded a prize because of non-membership. The awards were as follows: Normal Medal, to C. M. Saville, for his paper on "Hydrology of the Panama Canal"; J. James R. Croes Medal, to J. B. Lippincott, for that on "Tufa Cement as Manufactured and Used on the Los Angeles Aqueduct"; Thomas Fitch Rowland Prize, to H. T. Cory, for that on "Irrigation and River Control in the Colorado Delta"; James Laurie Prize, to S. T. Wagner, for that on "The Elevation of the Tracks of the Philadelphia, Germantown & Morristown Railroad, Philadelphia, Pa."; Collingwood Prize for juniors, to J. S. Longwell, for participation in the preparation of the paper "Experiments on Weir Discharge," W. G. Stewart, who collaborated with him, being ineligible for the prize on account of non-membership.

Officers

Officers for the coming year were elected as follows: President, Prof. Charles D. Marx; vice-presidents, Daniel Bontecou and Clemens Herschel; treasurer, Lincoln Bush; directors—district 1, J. V. Davies and G. A. Harwood; district 4, J. E. Greiner; district 6, J. F. Coleman and J. B. Hawley; district 7, H. S. Crocker; members of the nominating committee, Charles Hansel, J. W. Rollins, Jr., J. A. O'Connor, W. C. Cushing, Alexander Maitland, Jr., P. H. Norcross and Charles Derleth, Jr. The vote for directors of district 1 was as follows: J. V. Davies, 3013; Frederic Molitor, 1188; G. A. Harwood, 2192.

Announcement was made that the annual convention will be held in San Francisco, Sept. 15-19, immediately preceding the International Engineering Congress. The other three National engineering societies will hold similar conventions in San Francisco at the same time, and a movement is under way to run a special train from New York to San Francisco, leaving New York about Sept. 10.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Uniform Filter Statistics Are Now Possible

Committee of New England Waterworks Association Submits Final Report Recommending Standard Forms for Water Analyses

Uniformity in reporting statistics of water purification plants throughout the country will be possible as the result of the work of a committee of the New England Waterworks Association, consisting of Professor Geo. C. Whipple, chairman; Robert Spurr Weston, Francis D. West, Frank W. Green, and G. E. Lochridge, which submitted its final report at the annual meeting of the association held at the Hotel Brunswick, Jan. 13. Among other changes the report recommends that the use of the term "grains per gallon" be superseded by "pounds per million gallons" in referring to the treatment of water by chemicals. A set of standard forms for reporting the results of water analyses was presented with the report. The principal features of the committee's work are commented upon in the editorial columns of this issue.

New Officers Elected

The following officers have been elected to serve for the ensuing year: Leonard Metcalf, consulting engineer, Boston, president; James Burnie of Biddeford, Me.; Carleton E. Davis of Philadelphia, George F. Merrill of Greenfield, Mass.; Caleb M. Saville of Hartford, Charles W. Sherman of Boston, and William F. Sullivan of Nashua, N. H., vice-presidents. The additional members of the executive committee are Edwin C. Brooks of Melrose, Mass.; Samuel E. Killam of Boston, and George W. Batchelder of Worcester. Other officers are: Willard Kent of Narragansett Pier, R. I., secretary; Richard K. Hale of Boston, editor; Lewis M. Bancroft of Reading, Mass., treasurer.

At the meeting Desmond Fitzgerald, consulting engineer of Boston, showed and described a series of colored lantern slides of his travels.

President Wilson to Open Panama Canal March 10

President Wilson will formally open the Panama Canal on March 10, according to information received from Franklin D. Roosevelt, assistant secretary of the navy. The President will pass through the canal on board the battleship "Oregon."

Supreme Court Upholds Workmen's Compensation Law

The Supreme Court of the United States handed down a decision Jan. 4 upholding the constitutionality of the Ohio Workmen's Compensation Law. The constitutionality of this law was attacked on the ground that it exempted employers of less than five persons. The Supreme Court held, however, that this exemption could properly be made by the Ohio Legislature and did not violate the constitution. The decision was handed down in the case of Harry O. Blagg against the Jeffrey Manufacturing Company of Columbus.

Fire Wrecks Roebling Insulated Wire Plant

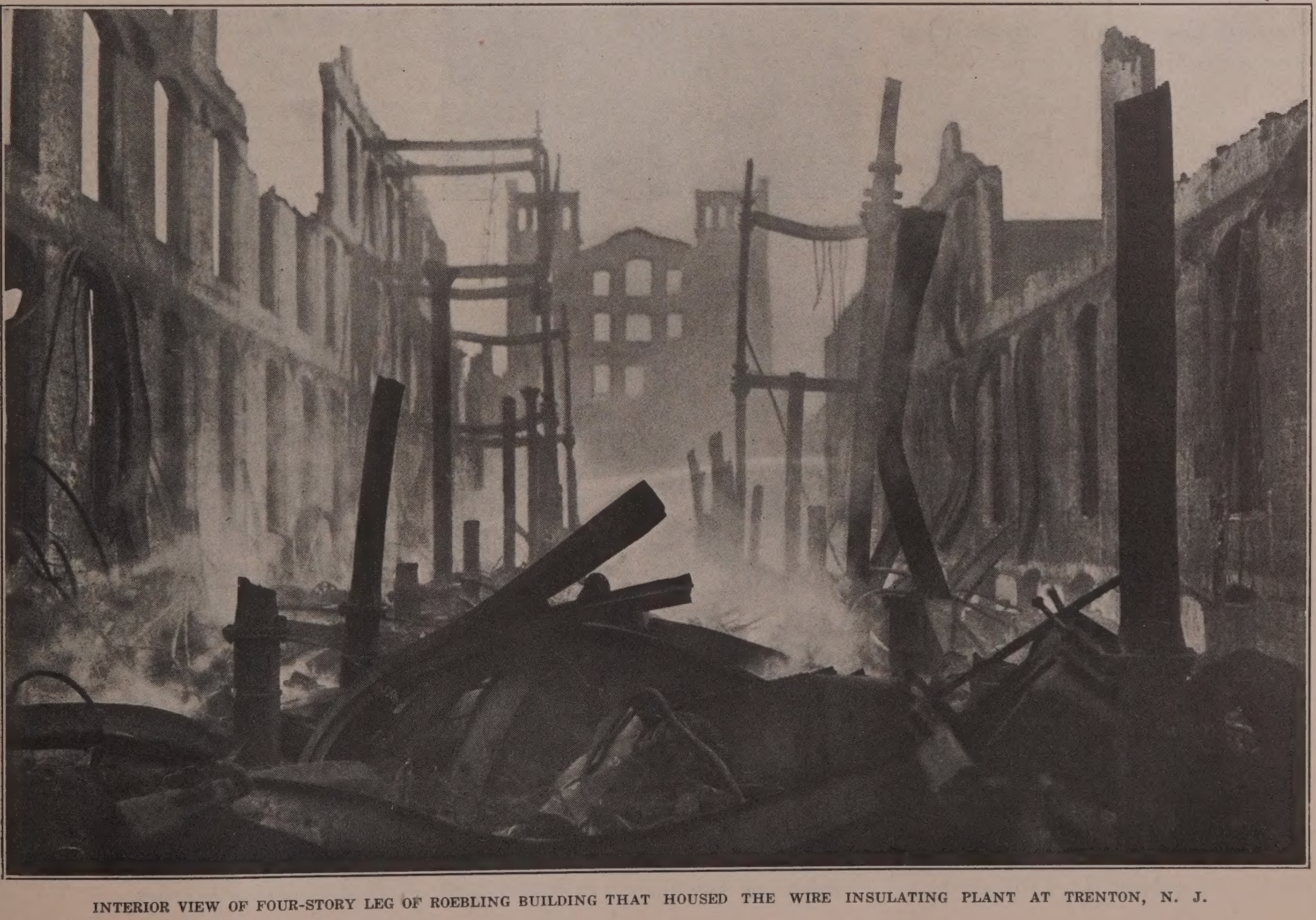
Intense Heat Fuses Cast-Iron Columns in Brick Building at Trenton, N. J.—Structure Is Total Wreck

Fire of unknown origin completely destroyed the insulated wire plant of the John A. Roebling's Sons Company, at Trenton, N. J., on the night of Jan. 18. It started near the center of the main building, which was U-shaped in plan. One leg and the connection were four stories in height, 65 ft. in width, 475 ft. and 350 ft. in length respectively. The other leg, 102 ft. in width and 325 ft. long, was two stories high. There was a basement under the entire building.

The building was built of brick with pilastered walls. Double wooden floors were carried on longitudinal joists supported by transverse steel girders and cast-iron columns. The tin roofs were on heavy sheathing and purlins supported on wooden trusses.

In the four-story portion were stored large supplies of highly inflammable fluids and bituminous materials used in the manufacture of insulating compounds. These, naturally, made the fire exceedingly hot and furthered its spreading to adjacent parts of the building.

In spite of the excellent work of the fire department, the flames gained such headway in a short time that on account of the high wind and flying sparks it was necessary for the firemen to devote their attention to the adjacent section of the city to prevent the fire from spreading. In addition to the city service and equipment the company maintained a high



INTERIOR VIEW OF FOUR-STORY LEG OF ROEBLING BUILDING THAT HOUSED THE WIRE INSULATING PLANT AT TRENTON, N. J.

pressure fire line, entirely surrounding the building, with hydrants at frequent intervals supplied from two pumps.

The building is a hopeless wreck, showing the forcing out of the walls, the bent and twisted steel and the broken cast-iron columns, typical of conflagrations in combination steel and brick buildings. The broken columns in the four-story leg clearly indicate that their failure has been due to heavy eccentric moments caused by the weight of the twisted steel. In places, where the connections between columns and girders appears to have been weak, the columns still stand. In one place, where the heat must have been intense enough to soften the cast iron, the expansion of the girder has bent the column considerably.

Cast Iron Columns Fused

In the two-story leg, where the lead insulating plant was located, the fire in the bituminous parts of the insulated wire was hot enough to fuse the cast-iron columns and drippings of molten metal are clearly visible on the remaining parts of the shafts. On Jan. 20, when the representative of the Engineering Record visited the plant, the building was still too hot to enter and the inclination of the standing portions of the brick walls made it dangerous to go too close. It could, therefore, not be definitely ascertained whether these drippings were cast iron or lead, but judging from the stubs of the columns, clearly showing that fusing had taken place, it is unlikely that lead could have congealed so near the top of the stub.

Between the legs of the main building was located a carpenter shop, housed in a frame building and provided with an asbestos roof. This building was the last to catch fire in spite of the intense heat from the adjacent conflagration.

The portion of the plant destroyed was devoted entirely to the manufacture of insulated wire for electrical purposes. The shops and machinery for the manufacture of all kinds of wire rope and bare iron, steel and copper wire were not damaged and are running.

Western Engineers to Attack Architects' Control of Structural Work

The architects' license law passed in Illinois eighteen years ago before the specialty of structural engineering had become a profession places in the hands of architects the positive control of the design and construction of buildings in Illinois. Structural engineers are, therefore, able to practise only as employees of architects.

The legislative committee of the Western Society of Engineers, in Chicago, is endeavoring to remove the handicap imposed on structural engineers by the present architects' law. It is necessary for this purpose to secure immediately a concise and comprehensive definition of a structural engineer as distinguished from an architect. Readers of the Engineering Record are requested to send in a definition in order that the bill may be properly drawn.

City Engineers to Lecture at Evening Classes

In accordance with the plan, announced in the Engineering Record of Dec. 26, page 682, for offering to engineers and assistants in the employ of New York City evening class instruction in engineering and allied subjects, the following men have been selected to deliver lectures during the year:

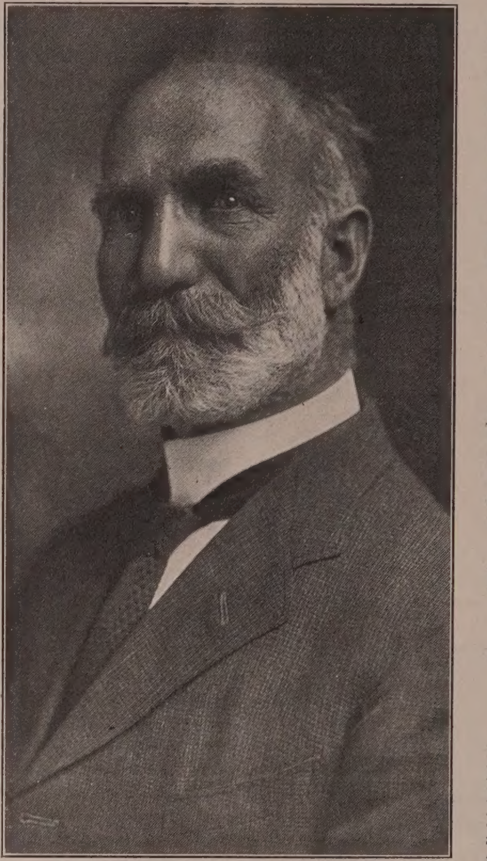
John T. Fetherston, commissioner of street cleaning; J. Waldo Smith, chief engineer, Board of Water Supply; Rudolph P. Miller, formerly superintendent of buildings; E. P. Goodrich, consulting engineer, Borough of Manhattan; A. D. Flinn, deputy chief engineer, Board of Water Supply; George W. Tillson, consulting engineer, Borough of Brooklyn; S. W. Hoag, Jr., deputy chief engineer, Department of Docks; and Arthur S. Tuttle, deputy chief engineer, Board of Estimate.

Professor Marx, American Society's New President

Engineer, Educator and Former Mayor of California City Recognizes Human Element in Engineering

Prof. Charles David Marx, whose election to the presidency of the American Society of Civil Engineers was announced at the annual meeting in New York this week, was born in Toledo, Ohio, on Oct. 10, 1857. His attendance in the public schools of that city was interrupted in 1863, when he went to Amsterdam with his father, who had been appointed American Consul at that point by President Lincoln. In 1866 he returned to Toledo and after finishing school there was sent to the Karlsruhe Real Gymnasium in 1871, from which he graduated in 1876. Entering Cornell in that year he took the degree of B. C. E. with the class of 1878.

THE NEWLY ELECTED PRESIDENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS



PROF. CHARLES DAVID MARX

After leaving Cornell he returned to Karlsruhe and in 1881 passed the examination for diploma at that institution. During 1880-81 he served as assistant to Prof. R. Baumeister and after the conclusion of his work he became, successively, levelman, transitman and draftsman on the proposed extension of the Boston, Hoosac Tunnel & Western Railroad, between the Genessee River and Niagara Falls. In this work he was engaged until 1882, when he became assistant engineer of the Missouri River improvement. During 1883-84 he was assistant engineer in charge of the Osceola Bar improvement on the Mississippi River.

During the period of 1884-90 he served as assistant professor of civil engineering at Cornell University and also acted during this time as chief inspector of public improvement for Rochester, N. Y., and as principal assistant engineer under the late Emil Kuichling in designing the east side trunk sewer for Rochester. He was also engaged as consulting engineer with the late Professor Galbraith for Smith estate at Trenton Falls.

He left Cornell to become professor of civil engineering at the University of Wisconsin during 1890-91. In 1891 he went to Leland Stanford, Jr., University, where he has since occupied the position of professor of civil engineering. In connection with his work at Stanford he has served as consulting engineer on a number of water projects for municipal erection and power purposes, and recently assisted in drafting the California water power bill which was adopted at the last election.

Professor Marx is a past-president of the Pacific Coast Association of Consulting Engineers, an organization which he represented as a delegate at the International Association of Consulting Engineers in Europe in the summer of 1913. He is also a past-president of the San Francisco Association of members of the American Society of Civil Engineers. In the parent society he has served on the board of direction, on the nominating committee and as vice-president. For several years he has found time to take an interest in the public life of Palo Alto, Cal., where he resides, having served on the board of trustees, board of public works and as mayor. As chairman of the California State Water Commission, Professor Marx accomplished monumental work in the codifying and defining of water rights, and the report of the commission is considered as marking an epoch in the State's development.

Professor Marx's most important work, however is conceded to be in the training of engineering students, in which field he has been eminently successful. A recent review of his work at Stanford points out that he "has always stood for a broad view of engineering problems so that his students become not merely computers of strains, but are taught to exercise judgment as a fundamental of engineering practice. His recognition of the human element in engineering has accomplished much in the fostering of closer relations among engineers."

Millions Spent for New York Subways During 1914

Public Service Commission, in Annual Report Announces That Sixty-Four Sections of New Transit System Are Under Contract

In the eighth annual report of the Public Service Commission to the New York State Legislature it appears that contracts for the New York City subway work awarded in the year 1914 aggregated more than double the amount of those awarded in the previous year, the figures for 1914 and 1913 being $52,000,000 and $24,000,000 respectively. The money disbursed in payment to contractors on transit system during 1914 amounted to $26,000,000. At the close of the year sixty-four of the eighty-three sections of the city-owned lines of the new system were under contract, the aggregate of the contract prices for these sections being about $142,000,000.

The running expenses of the commission during the year amounted to practically $3,000,000, of which $2,500,000 was directly chargeable to rapid transit. The total number of employees at the end of the year was 2100, of whom 1800 were engaged exclusively on rapid transit work. During the fiscal year ending June 30, 1914, over 1,183,000,000 passengers were carried on all street railroads in the first district, an increase of more than 43,000,000 over the previous year. The total receipts of the companies, which include elevated, subway and surface lines, for the same period was $94,153,673.93, or about $17.43 per capita.

Washington Bill Fixes Minimum Wage on Public Works

Edward W. Olson, State labor commissioner of Washington, is having prepared in the office of the attorney-general a bill for submission to the Legislature providing for a minimum wage on all public works and also giving domestic laborers preference over foreigners or residents of other localities.

Western Engineers Meet Goethals

The Western Society of Engineers and the Chicago Engineers' Club entertained Colonel Goethels on Jan. 22, at luncheon in the La Salle Hotel, Chicago. W. H. Finley, past-president of both organizations, presided.

News of Engineering Societies

The Minnesota Surveyors' and Engineers' Society held its annual meeting Jan. 19 and 20 at St. Paul, Minn.

The Cleveland Engineering Society, at its meeting on Jan. 12, heard a paper on the Development of Mechanical Flight by H. C. Gammeter.

The American Institute of Consulting Engineers held its annual meeting on Jan. 19 at New York City. The meeting was preceded by an informal dinner.

The Boston Society of Civil Engineers will hold a meeting Jan. 27, at which Nathan H. Daniels will read a paper on Insurance as of Interest to the Engineer.

The Idaho Society of Engineers will hold its annual convention in Boise, Jan. 26, 27 and 28, overlapping the conference of the United States Reclamation Service which will be held Jan. 27 to 29.

The Engineers' Club of St. Louis was addressed at its last regular meeting, Jan. 20, by S. W. Bowen, on the design and construction of the reinforced-concrete viaducts at Fort Worth, Texas.

The Vancouver Branch of the Canadian Society of Civil Engineers held its regular meeting on Thursday, Jan. 7. An illustrated paper on Vancouver Joint Sewerage Scheme was presented by A. D. Creer.

The Oregon Irrigation Congress at its recent meeting in Portland, Ore., elected the following officers for the year 1915: President, Asa B. Thompson; secretary, Frederick N. Wallace; vice-presidents, J. W. Brewer, John Rigby and A. M. Crawford.

The Ohio Waterworks Association held its fourth annual meeting in Columbus on Jan. 20 and 21. The association was addressed by several prominent State officials and ten questions relating to water supply were presented for general discussion.

The Municipal Engineers of the City of New York will hold their annual meeting, to which ladies are invited, in the Engineering Societies Building, on Jan. 27, at 8:15 p. m. Professor James F. Kemp, of Columbia University, will deliver a lecture on Cuba.

The Engineering Foundation will be inaugurated Jan. 27 in the auditorium of the Engineering Societies Building, New York City. The speakers at this inauguration meeting will be Gano Dunn, Henry S. Pritchett, Robert W. Hunt and Alexander C. Humphreys.

The Engineers' Society of Northeastern Pennsylvania held a special meeting on Monday, Jan. 18, at which they were addressed by William A. Blonck on European boiler room practice and boiler efficiency methods in the United States with reference to electric light and power plants.

The American Society of Engineering Contractors held its annual meeting in New York City, Jan. 15. Several addresses were delivered and matters of importance discussed. In the evening a banquet and entertainment was held at Bustanoby's. The manufacture of pipes at the National Tube Company's works and the jetting down of 50-ft. reinforced concrete piles were shown in moving pictures.

The Pacific Northwest Society of Engineers has elected the following officers for the year 1915: President, Marvin Chase; vice-presidents, D. W. McMorris, A. P. Denton and A. S. Downey; secretary, Jesse A. Jackson; treasurer, Wendell N. Chase; librarian, C. E. Hill; directors, J. D. Blackwell, Almon H. Fuller, George P. James, Milnor Roberts, J. J. Cryderman, George A. Kyle, T. A. Noble and R. H. Thomson.

Personal Notes

J. W. Barnett has been re-elected city engineer of Athens, Ga.

H. J. Hanmer has been reappointed city engineer of Gloversville, N. Y.

Grant Davis has been reappointed county engineer for Hunterdon County, N. J.

Paul L. Bean has been made engineer to the Public Utilities Commission of Augusta, Me.

Carl Bucholtz has been appointed division engineer of the Leedsville division of the Erie Railroad.

Elbert W. Sylvester was reappointed city engineer and superintendent of public works at Poughkeepsie, N. Y.

T. J. Wasser has recently been reappointed county engineer of Hudson County, N. J., for a term of three years.

Major C. W. Kutz, Corps of Engineers, U. S. A., has been chosen chairman of the public utilities commission, Washington, D. C.

Julien Smith, a highway engineer, of Selma, Ala., has been appointed by the Governor of that State as a member of the State Highway Commission.

W. A. McLean, provincial engineer of highways, Ontario, Can., addressed on Jan. 13 a large gathering of members of the Engineering Society of the University of Toronto.

Alfred D. Flinn, deputy engineer of the Board of Water Supply, New York, delivered on Jan. 13 before the Men's Club of the Church of Our Father, a lecture on New York's New Aqueduct.

H. H. Lindemuth of York, Pa., has resigned as president of the York Engineering Company. He will again engage in business at York under the name of the Lindemuth Engineering Company.

G. W. Rice, who has been chief engineer of the Goose Lake Valley Irrigation Company in the construction of an irrigation project near Lake View, Ore., has resigned upon completion of construction work.

W. M. Wilkes, who has been associated with the J. B. McCrary Company, municipal engineers of Atlanta, Ga., has resigned his position with that company and will shortly enter business for himself in that city.

Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment, New York City, delivered on Jan. 22 a lecture on City Planning before the Civil Engineering Society of the Brooklyn Polytechnic Institute.

F. M. Thomson, assistant engineer of the Houston & Texas Central at Ennis, Texas, has been appointed assistant superintendent of the El Paso Division, at El Paso, Texas, of the Galveston, Harrisburg and San Antonio, succeeding C. R. Morril.

Capt. Thomas M. Robins, Corps of Engineers, U. S. A., has been assigned to report to the commanding general, Eastern department, for duty pertaining to the inspection of a regiment of engineers, organized militia of the State of New York.

Henry D. Alexander has been appointed deputy superintendent of public works of the State of New York by Major Wotherspoon. Since graduating from Cornell twenty-two years ago Mr. Alexander has had wide experience in railroad and canal work.

Arthur H. Diamant, formerly with the Aqueduct Commission of New York and recently construction engineer of the Canavan Brothers Company, has been elected president and managing engineer of the Excavation and Foundation Company of New York City.

J. E. A. Moore has been taken into partnership by Virgil G. Marani, consulting engineer of Cleveland, Ohio. The firm will specialize in the design of fireproof building construction. Mr. Moore was formerly partner of the late J. W. Seaver, and was later chief engineer of the C. O. Bartlett Snow Company.

L. F. Harza & Company have opened offices at 413 and 414 Spalding Building, Portland, Ore., to engage in consulting, designing and supervising hydraulic work. With Mr. Harza is associated Victor H. Reineking, who has just finished supervising the reconstruction of the Elwha River dam. Mr. Harza has just completed an elaborate study of the proposed Columbia River Project, for the United States Reclamation Service.

Obituary Notes

Frank Solon, former superintendent of streets for Chicago, died in that city, Jan. 11.

C. G. Rasinsky, member of the firm of Shipley & Rasinsky of Cincinnati, O., died Dec. 26 at that city.

Chauncey Ives, formerly chief engineer of the Cumberland Valley Railroad, was later engaged in construction work on the tunnels in New York City, died Jan. 4 at Hood River, Oregon.

Alphonse Feldpauche died on Jan. 5 at Philadelphia at the age of sixty-six. He was formerly chief engineer of the Philadelphia, Wilmington and Baltimore railroad and later secretary of the Association of Transportation Officers of the Pennsylvania railroad.

Charles S. Price, engineer and general manager of the Cambria Steel Company, and later its president, died Jan. 10, at his home in Westmont, Pa. Mr. Price was a graduate of Cornell University and began work with the company of which he was president as a draftsman in 1876.

John M. McKenzie, for a time assistant to the chief engineer of the New York, New Haven & Hartford Railroad, died from a fall sustained Dec. 26 at his home near Wallingford, Conn. He built Carnegie Lake at Princeton and was engaged recently in the practice of civil engineering with his brother, T. H. McKenzie, of Wallingford.

Christopher S. Gadsden, second vice-president of the Atlantic Coast Line, died at Summerville, S. C., on Jan. 12. He began railway work in 1853 as rodman in an engineer corps of the New Orleans and Great Northern, now a part of the Illinois Central. He was subsequently engineer on the Franklin & Warren, now a part of the Erie, and later was in the service of the Port Royal and Augusta in South Carolina, now a part of the Charleston & Western South Carolina and of the Charleston and Savannah railroads. He was superintendent of the Charleston & Savannah railroad until October, 1900, when he became president of the same road. Mr. Gadsden was also third vice-president of the Atlantic Coast Lines till November, 1902, when he was made second vice-president of that road.

Civil Service Examinations

Civil Service Examinations Previously Announced

Date		See Engineering Record
Feb. 2, 1915	Sanitary engineer, United States	Jan. 2
Feb. 3, 1915	Structural steel draftsman, topographic aid, civil engineer student, copyists, ordnance draftsman, United States	Jan. 16
Feb. 4, 1915	Ordnance draftsman, United States	Jan. 16
Feb. 6, 1915	Assistant utilities engineer, Illinois State	Jan. 16

Coming Meetings of National Engineering Societies

AMERICAN SOCIETY OF CIVIL ENGINEERS. Secretary, Charles Warren Hunt, 220 West 57th St., New York. Meets first and third Wednesday, except in July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Secretary, Clement H. McLeod. Meets Thursdays, in Montreal, except during the months of May to September, inclusive.

INTERNATIONAL ENGINEERING CONGRESS. Secretary-Treasurer, W. A. Cattell, Foxcroft Building, San Francisco, Cal. Meeting Sept. 20-25, 1915, San Francisco, Cal.

Coroner's Jury Blames Law for Elevator Accident

The owners of the California Pacific Building in San Francisco, in which an elevator recently plunged eight floors to the basement, killing one of the occupants and injuring nine others, are not held responsible for the accident by the coroner's jury. The jury declared that "the real cause of this accident is the lack of properly constituted authority to compel the owners of buildings to replace cables after they have been notified by the inspector that the cables are unsafe." The verdict was rendered at the inquest held on the death of Harold H. Fitting, a civil engineer, who died a few hours after the accident.

The jury recommended that ladders be required in elevator shafts; that each cage should be accessible in emergencies, through its top; that a ban should be placed on heavy elevator cages or those carrying much glass. In order to fix responsibility, the jury found that a revision of the law should be made so that notice must be given by elevator inspectors to specified authorities so that whenever an elevator is not in perfect working condition there will be authority to immediately stop its operation until it has been properly repaired and so reported by inspectors.

Leonard Metcalf Heads New England Waterworks Association

Leonard Metcalf, of the firm of Metcalf & Eddy, consulting engineers of Boston, was elected president of the New England Waterworks Association at the annual meeting held in Boston, Jan. 13. During recent years he has devoted most of his time to the valuation of public utilities and is recognized as an expert in this specialty. Mr. Metcalf was born in Galveston, Texas, in 1870, and graduated from the Massachusetts Institute of Technology in 1892. For three years after leaving college he was employed by the firm of Wheeler & Parks, civil engineers of Boston, as assistant engineer on the construction of dams and water purification plants, pumping stations and pipe systems. From 1895 to 1897 he was professor of mathematics and engineering at the Massachusetts Agricultural College. He resigned to enter private practice in Boston and formed a partnership with Harrison P. Eddy. A great deal of Mr. Metcalf's early work as consulting engineer related to the design and construction of sewerage systems and waterworks plants. Mr. Metcalf is co-author with Mr. Eddy of the book, "American Sewerage Practice," the first volume of which has just been published.

Gen. Bingham and Leon S. Moisseiff Leave Bridge Department

General Theodore A. Bingham, consulting engineer to the Department of Bridges, New York City, and Leon S. Moisseiff, engineer of design, have resigned, effective Feb. 1. The fact that the city is doing little bridge construction work at present and has adopted a policy of retrenchment are the reasons given by Commissioner F. J. H. Kracke for dispensing with the services of these two engineers. General Bingham is a man who has been in the public eye for many years. During Mayor McClellan's administration he was appointed police commissioner of New York City and served in this capacity for three years. He then opened an office for the practice of consulting engineering in Washington which he left in May, 1911, to accept the position of chief engineer of the Bureau of Highways, Borough of Manhattan, New York City. It is said that there was too much politics connected with the administration of this work to suit General Bingham and he soon gave it up. General Bingham graduated from the United States Military Academy in 1879 and served actively in the Corps of Engineers, U. S. A., until 1904, rising to the rank of Major. Shortly after he was appointed a brigadier-general and placed on the retired list.

Mr. Moisseiff is a graduate of the School of Mines of Columbia University, class of '95. He has taken an active part in the design of New York's great bridges across the East River including the Manhattan Bridge, Brooklyn Bridge, Williamsburg Bridge and Queensboro Bridge. In June, 1907, Mr. Moiseiff was in charge of the plans for the proposed Henry Hudson memorial bridge, a reinforced concrete arch of 725 ft. span.

Five Hundred Attend Annual Meeting of Western Society

Enthusiasm engendered by a record breaking attendance at the annual meeting of the Western Society of Engineers, Jan. 13 and 14, indicates that the society has awakened to a new sense of its obligations. Nearly 400 men participated in one of the most democratic annual dinners ever given by the society, 520 persons went on the excursion and 325 attended the smoker.

WAITING FOR THE EXCURSION "SPECIAL"

E. H. Lee, president, presided for a short time while J. H. Warder, secretary, gave a brief résumé of the society's activities for the past twelve months and announced the award of the Octave Chanute medal to O. H. Basquin for his paper on "Columns" and Thomas V. Salt for his paper on "The Manufacture of By-Product Coke."

President's Address

Mr. Lee, in his presidential address, brought out forcibly some of the points that have been commented on editorially in recent issues of this journal, viz., the prodigious amount of hard work done by committees of the society which is little appreciated by some of its members. The legislative committee has nearly ready an act for submission to the Illinois Legislature designed to remove some of the unjust disabilities laid upon engineers by existing laws. Negotiations are under way to secure more adequate quarters for the society. The younger members have been given an opportunity to serve the society on committee work and have done so most effectively. The burden of Mr. Lee's further remarks had to do with railroad regulations.

William B. Jackson, the newly elected president, presented the society's claim on the individual for support, because credit for the bettering of the engineer's condition is due to organization.

That the engineer can help materially in solving State and national problems of finance and government was emphasized by Hon. Harry Olson, chief justice of the Chicago municipal court and by H. A. Wheeler, banker.

Dr. R. A. White spoke on the Philippine problem, paying a special tribute to the work of engineers on the islands. Governmental efficiency, he said, is so much more in evidence there than in this country that it is noticeable even to a layman. He advised sending some of our political heads there in groups of twenty-five to learn efficiency.

The excursion was planned originally for 250 members, but the dinner was so successful that the arrangement committee had to provide for more than twice this number. Through the courtesy of the Chicago & Western Indiana a special seven-coach train was provided.

The first stop was at the new industrial plant of the Crane Company, which has twenty-seven buildings finished or under construction aggregating 25 acres of floor space. As the Clearing yards were passed explanations were given of this $8,000,000 project which will be put into operation this spring. Through the courtesy of Sears Roebuck & Company, lunch was served at their plant before starting on the inspection of the mechanical appliances in this mail order house, from which 45,000 orders are shipped daily.

The newly elected officers are, President, William B. Jackson; vice-presidents, Ernest McCullough, C. B. Burdick and P. B. Woodworth; treasurer, C. R. Dart, and trustee, O. P. Chamberlain.

Business Notes

The Asbestos Protected Metal Company will move its general offices on Feb. 1 from its Beaver Falls plant to the First National Bank Building, Pittsburgh.

The Atlas Engineering Company, of Cleveland, Ohio, has established an office at Canton, Ohio, to supervise the erection of a 1500-bbl. cement plant for the O. C. Barber Mining and Fertilizer Company.

The W. H. Anderson Tool & Supply Company, of Detroit, has opened offices accompanied by an exhibit of concrete mixers and other equipment in the Railway and Contractors' Supply, Permanent Exhibits in the Lytton Building, Chicago. F. B. Talley is the Chicago representative.

Trade Publications

Arex Company, Chicago, Ill. Leaflet, 4 pages, illustrating and describing the Arex original siphonage ventilator, "The Power Fan's Only Rival."

Nash Engineering Company, South Norwalk, Conn. Bulletin 3, 4 pages, dealing with the Nash hydro-turbine, air compressors and vacuum pumps of the single stage type.

Cyrus William Rice, Philadelphia. Pamphlet, 8 x 10½ in., 24 pages, illustrated. Intermittent circulating aerating system for softening and purifying water. The sales manager is Edward F. Harrison, 6616 Woodland Avenue, Philadelphia.

Harrison Safety Boiler Works, Philadelphia, Pa. Catalog, 72 pages, dealing with Cochrane multiport valves for back pressure service; for atmospheric relief in vacuum service; for flow service in connection with mixed flow steam turbines, and for bleeder or extraction service. Well illustrated.

De Laval Steam Turbine Company, Trenton, N. J. Catalog B, 298 pages, 300 illustrations, dealing with De Laval high efficiency centrifugal pumps, single-stage and multiple stage types for all capacities and for all heads. The book describes their characteristics, design, manufacture, testing, selection and adaptation to various uses. Speed reducing gears and turbine driven water works pumps are dealt with in separate chapters.

Leupold, Voelpel & Company, Portland, Ore. Bulletin 3, 12 pages, describing Stevens continuous water-stage recorders; bulletin 4, 13 pages, showing Stevens differential water-stage recorder; bulletin 5, 7 pages, dealing with Stevens long-distance water-stage recorder; bulletin 6, 5 pages, illustrating the Stevens 8-day recording water gage; bulletin 7, 5 pages, containing a photograph and text on Stevens type C water-stage recorder for rapid fluctuations, and bulletin 8, 4 pages, advertising Stevens weight and hook gage.